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Mobile Radio Technology

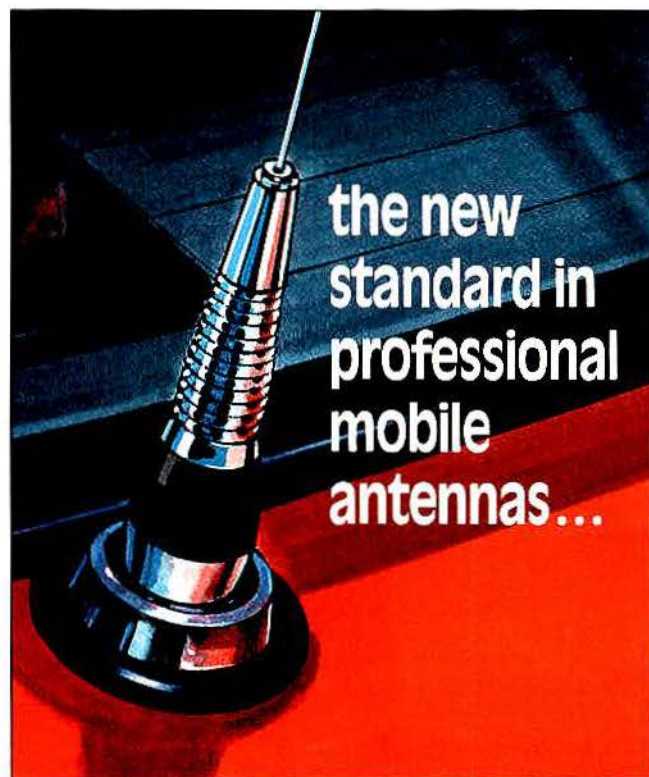
The journal of mobile communications technology

POCSAG
group calls, p.10

Receiver voting combiners
IMCE/Spring show preview/guide



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A.O.J. Woodfield

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MRT staff

More than 300 mobile communications equipment manufacturers, distributors and service providers will convene at the Anaheim Convention Center, and many exhibitors will debut new products and services as they gear up for 1993. Use our pull-out map and exhibitor list to guide you through the exhibit hall.

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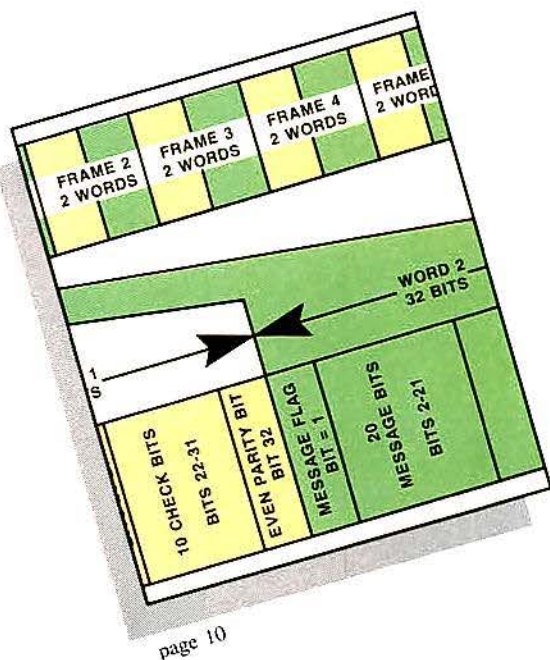
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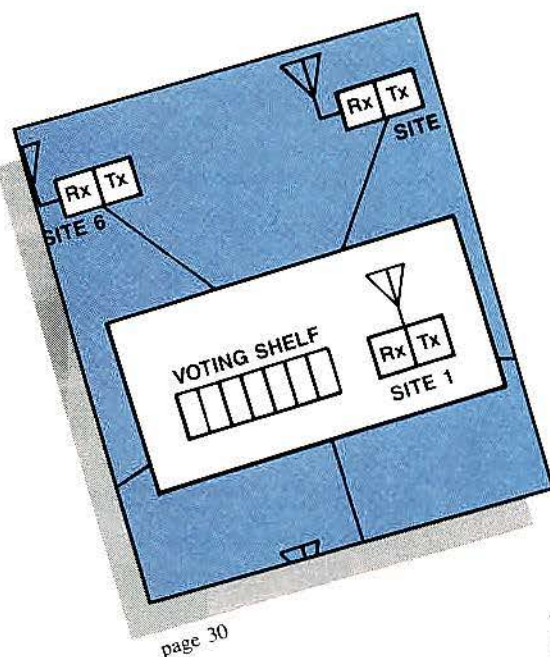
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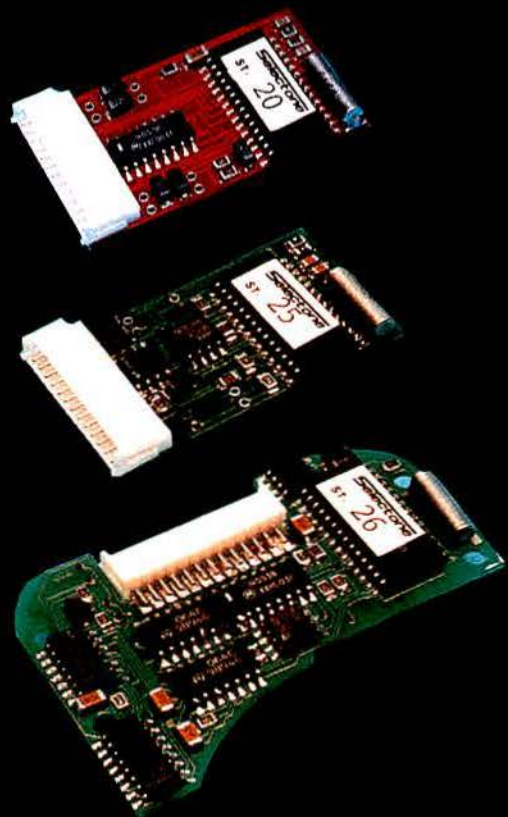


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Emergency Medical Radio Service



New radio service

The FCC has approved a new radio service called the Emergency Medical Radio Service (EMRS).

The service was requested three years ago by the International Municipal Signal Association (IMSA) and the International Association of Fire Chiefs (IAFC) on behalf of their members who provide life support services. The FCC has designated IMSA and IAFC jointly as the frequency coordinator for EMRS license applications.

A *radio service* is formed when the government issues regulations that define technical standards, operating characteristics, license eligibility and frequency allocations for a given type of radio communication.

Radio users seek the formation of a new radio service when there is something to be gained, such as quicker access to clear frequencies and less interference.

Radio users within the EMRS will include "persons or entities engaged in the provision of basic or advanced life support services on an ongoing basis," according to the FCC. Examples include fire and rescue agencies of local government operations that have paramedics, emergency medical technicians, hazardous material teams and volunteer fire departments that perform pre-hospital medical services.

Previously, many life support service providers have used the Special Emergency Radio Service (SERS) frequencies for radio communications.

Apparently, the SERS frequencies carry so much traffic that many life support service providers were unable to use them as freely as necessary to sustain their missions.

One of the most often cited sources of interference to life support service operations on SERS frequencies is school bus radio communications. Others who share SERS frequencies include veterinarians, handicapped persons, disaster relief organizations, beach patrols, establishments in isolated places, communications standby facilities and public communications facilities repair services.

In creating the new radio service, the FCC will reallocate some SERS frequencies and add some frequencies from the new 220MHz land mobile radio band.

The formation of the new radio service reflects the inability (or perhaps sometimes the unwillingness) of some SERS licensees to coordinate their radio use with life support service providers. To give them the benefit of the doubt, there may be technical reasons why some users would be unaware that their radio operations were interfering with communications among life support service providers.

To the extent that this new radio service solves the life support service providers' radio communications problem relative to other radio users, creating the EMRS is a good idea.

Interestingly, the EMRS is being created at the same time the FCC is proposing to consolidate the now-20 private radio services into three: Public Safety, Non-Commercial and Specialized Mobile Radio.

SERS licensees, including life support service providers licensed in that service, might be expected to be consolidated into frequencies allocated for the Non-Commercial Radio Service. Consolidation can be expected to sweep EMRS licensees into the Public Safety Radio Service where they will be accorded a higher priority for protection from congestion and interference than they would be in the proposed Non-Commercial Radio Service.

This likelihood makes the creation

of the EMRS right now all the more opportune to life support service providers that use radio communications.

For the present, EMRS licensees stand to benefit through access to shared public safety "pooled" channels that are not available to life support service providers as SERS licensees.

There was a lot behind the creation of the EMRS, including a perceived public need, the IMSA and IAFC petition, Congressional support and finally the FCC action on Jan. 14.

We hope those who are on the receiving end of life support services will be better served as the result of improved radio communications that the new EMRS is intended to deliver.

* * *

Cellular health risk

As this column is being written, TV programs are reporting assertions some people are making that portable cellular telephones represent a health risk.

We've seen these reports on all of the over-the-air networks, network affiliates' local news programs and several cable networks.

Some of the news reports we've seen took care to point out the difference between hand-held telephones, against which claims of illness and death have been made, and mobile telephones, against which (as of now) no complaints have been lodged. Other reports were illustrated, perhaps carelessly, with video showing people using mobile telephones, possibly conveying the wrong impression.

We would be interested in receiving from our readers copies of any clippings, articles and technical papers on the subject of the potential health risk posed by the energy emitted by radio equipment.

What will affect the industry the most as far as this health question is concerned is the *public perception*, which, unfortunately, may not be based on correct information. Nevertheless, it helps to have the most accurate and up-to-date information available.

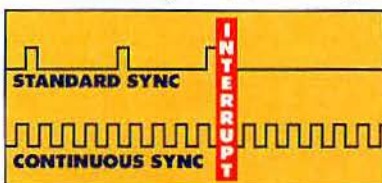
—Don Bishop

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- 2-4—Cellular Telecommunications Industry Association Winter Meeting and Exposition, Dallas Convention Center, Dallas. Contact: 202-785-0081.
- 17-19—Western States Regional Conference Associated Public-Safety Communications Officers Meeting, Hyatt Regency, Phoenix. Contact: Deborah L. Overton, 602-256-1029.
- 21-24—Energy Telecommunications and Electrical Association, New Orleans Convention Center, New Orleans. Contact: 214-235-0655.
- 23-25—International Mobile Communications Expo/Spring, Anaheim Convention Center, Anaheim, CA. Contact: 303-220-0600.

April

- 19-22—Supercomm and Telocator Wireless Conference, Georgia World Congress Center, Atlanta. Contact: 800-326-8638.
- 21-23—North Central Regional Conference Associated Public-Safety Communications Officers Meeting, Radisson Inn Bismarck, Bismarck, ND. Contact: Lyle V. Gallagher, 701-224-2127.

May

- 12-14—Mobile Communications Conference, sponsored by the National Association of Business and Educational Radio (NABER), Hyatt Regency Hotel, San Antonio. Contact: 800-759-0300.
- 16-19—East Coast Regional Conference Associated Public-Safety Communications Officers Meeting, Cavalier Hotel, Virginia Beach, VA. Contact: Bill Marriott, 804-247-8431.
- 18-20—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Meadowlands Hilton, Secaucus, NJ. Contact: Stuart F. Meyer, 703-281-3806.
- 26-28—RadioComm, Metro Toronto Convention Centre, Toronto. Contact: Lisa La Prairie, 613-233-4888.

June

- 29-July 1—Utilities Telecommunications Council Annual Meeting, San Antonio Marriott Rivercenter and Convention Center, San Antonio. Contact: Rita Clark, 301-621-7802.

July

- 18-22—Forestry-Conservation Communications Association, Jackson, WY. Contact: Don Pfohl, 602-644-3166.

August

- 8-13—Associated Public-Safety Communications Officers 59th National Conference, New Orleans Convention Center, New Orleans. Contact: 800-824-1850.

September

- 21-23—International Mobile Communications Expo/Fall, Philadelphia Convention Center, Philadelphia. Contact: 303-220-0600.
- 28-Oct. 1—Mobile Communications Marketplace, New Orleans Convention Center, New Orleans. Contact: Telocator, 800-326-8638.

October

- 6-9—Industrial Telecommunications Association Annual Meeting, La Quinta Hotel, La Quinta, CA. Contact: Barbara J. Levermann, 703-528-5115.
- 12-13—SMR/Private Carrier Management Conference, Loews Coronado Hotel, San Diego, CA. Contact: 202-331-7773.
- 16-21—International Association of Chiefs of Police Annual Conference, Cervantes Convention Center, St. Louis, MO. Contact: 703-836-6767.

November

- 19—Radio Club of America Awards Banquet, New York Athletic Club, New York. Contact: 201-652-6811.

1994

February

- 7-8—AMTEX, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Marriott on International Drive, Orlando. Contact: 202-331-7773.



Mobile Radio Technology

The journal of mobile communications technology

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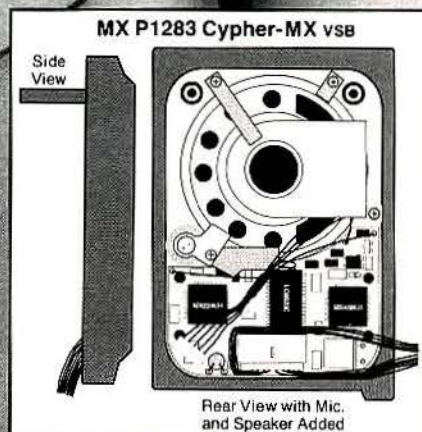
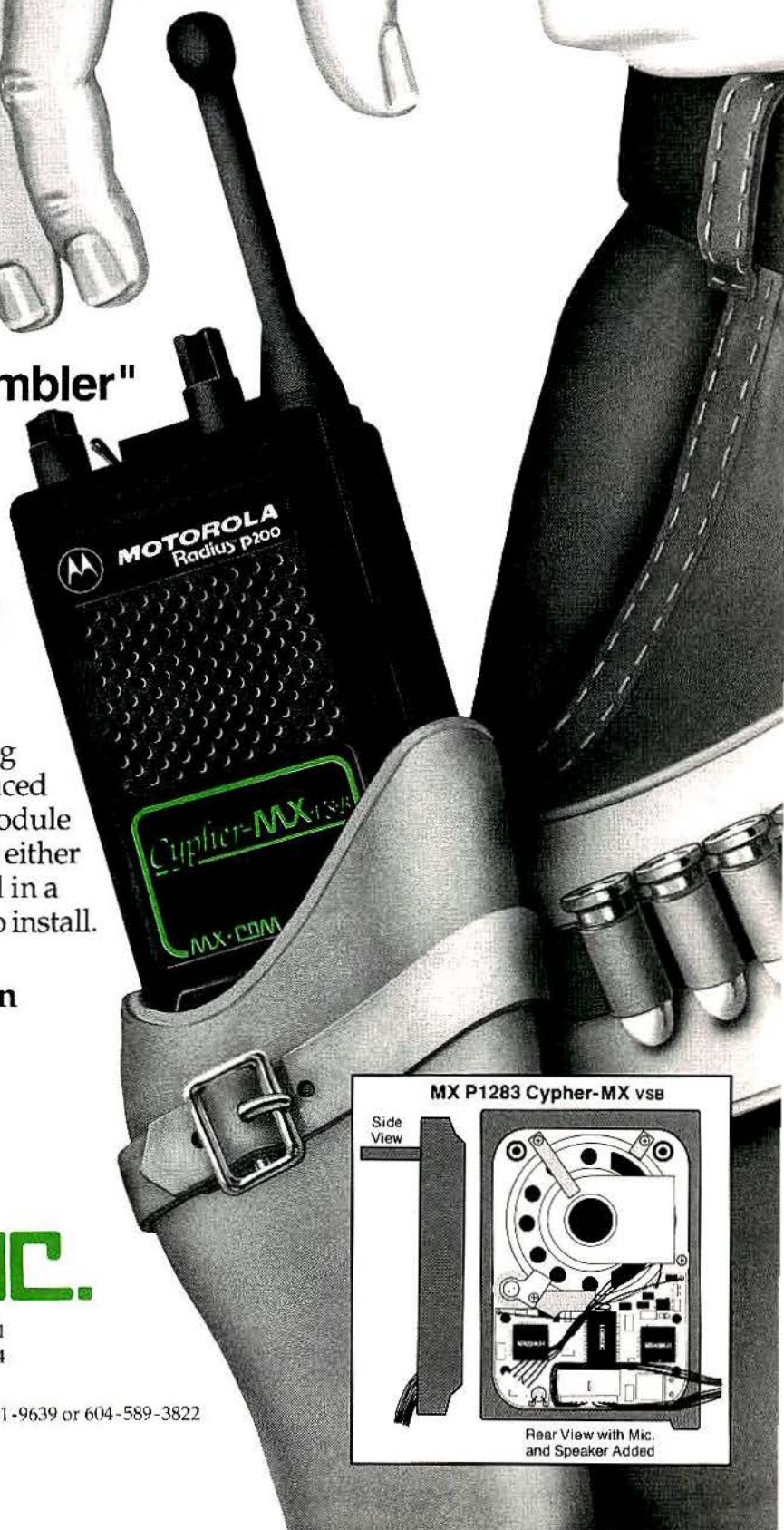
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Circle (7) on Fast Fact Card



Designing your own pads, part 2

By Harold Kinley, CET

Attenuators and impedance-matching pads can be useful around the radio shop.

Attenuators and pads are used for RF and audio applications. Eventually, you may need to build your own attenuator for a special purpose.

In February's column, a few basics about L-pads, T-pads and π -pads were discussed that will help you when you build your own.

The conversion of T-pads to π -pads and π -pads to T-pads can help you reduce a combination of L-pad and π -pad or T-pad to one simple equivalent π -pad or T-pad for impedance matching.

Conversions

Here is how to convert π -pads to T-pads and vice versa.

Figure 1A shows a T-pad with resistance labeled R_1 , R_2 and R_3 . An equivalent π -pad is shown at 1B.

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

The π -pad resistances are labeled R_a , R_b and R_c . The figure's formulas can be used to convert from a T-pad to an equivalent π -pad and vice versa.

Using an electronic calculator with a memory function, it is easy to apply the formulas. Notice that in converting from T-pads to π -pads, the numerators are the same for each resistance calculation. The numerator can be stored in the calculator's memory and reused for each resistance calculation.

In the π -pad to T-pad conversions, the denominators are the same for each resistance calculation. For these conversions, the denominator can be stored in memory for reuse.

Practical application

Figure 2A is a simple L-pad.

The L-pad is used to match a 75 Ω impedance to a 50 Ω impedance. This pad attenuates the signal by approximately 5.7dB. Because this is an odd value, it might be desirable to change the attenuation to an even value, such as 10dB.

It would be impossible to build an L-pad to provide a *bidirectional* 75 Ω /50 Ω impedance match at a 10dB loss. Nevertheless, by using a π -pad with an attenuation of 4.3dB in cascade with the L-pad, an equivalent T-pad with 10dB

attenuation can be derived.

A π -pad with 4.3dB attenuation is shown in Figure 2B. The L-pad and π -pad are connected in cascade. (See Figure 2C.) Notice that R_L of the L-pad and R_a of the π -pad are connected directly in parallel.

These two resistances can be replaced with a single 60 Ω resistance, R_a , shown at Figure 2D. Upon further examination of Figure 2D, you will notice that a new π -pad has emerged. It consists of resistances R_a , R_b and R_c .

Using the conversion information from Figure 2, the π -pad at Figure 2D can be transformed into a T-pad, as shown at Figure 2E.

Upon further examination of the resulting pad at Figure 2E, you will notice that the two series resistances R_a and R_1 can be combined into a single resistance of 48.6 Ω as shown at Figure 2F.

A simple asymmetrical T-pad has evolved from the combination of the L-pad at Figure 2A with the π -pad at Figure 2B. The resultant T-pad maintains a *bidirectional* impedance match and provides the desired 10dB attenuation.

Although there are formulas to use to

(continued on page 79)

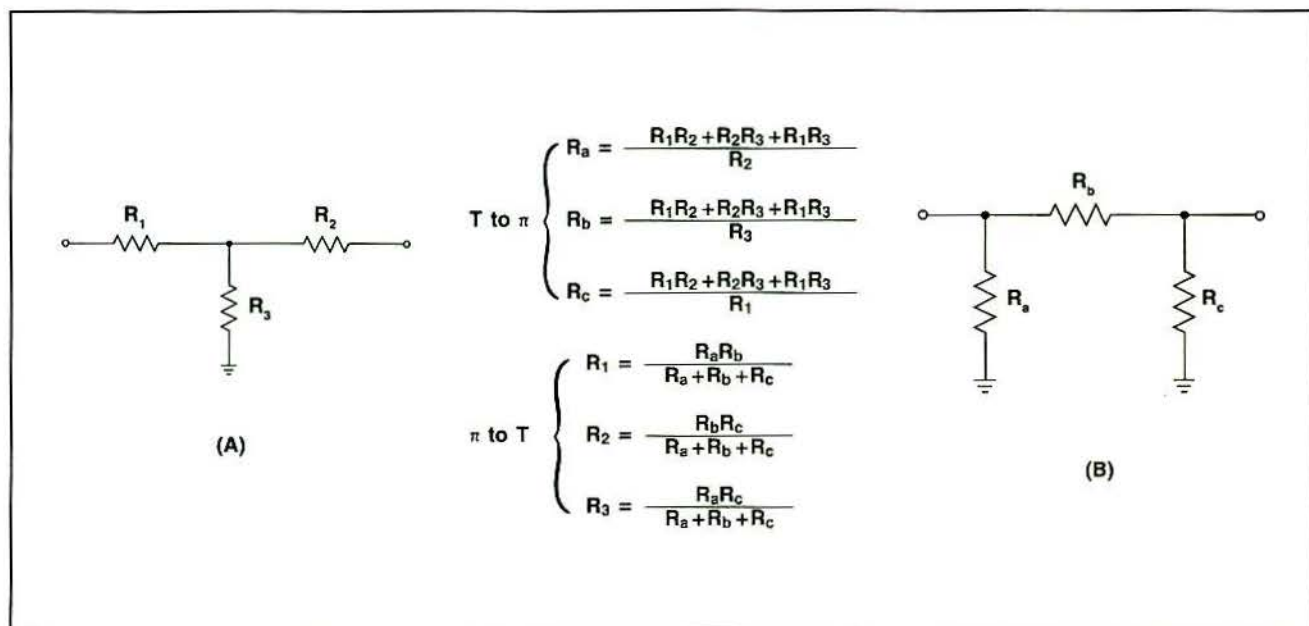


Figure 1. A T-pad with resistance labeled R_1 , R_2 and R_3 is shown at 1A. An equivalent π -pad is shown at 1B. The π -pad resistances are labeled R_a , R_b and R_c . The figure's formulas can be used to convert from a T-pad to an equivalent π -pad and vice versa.

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Assign POCSAG group calls for information services

Here is how carriers can overcome problems inherent in POCSAG group code assignment and select an appropriate solution to send information services to subscriber groups with a minimum of airtime.

By James W. Marion
and John Lewis

Carriers increasingly are offering value-added information services to standard alphanumeric paging to attract and to keep more alphanumeric subscribers.

These alphanumeric services aid in overcoming common objections to alphanumeric use, such as the difficulty of sending alpha pages and higher

service fees. In addition, information services can aid in increasing monthly service revenue for the carriers.

Many information services are commonly available, such as sports news, headline news briefs, stock information, local weather and traffic. The typical information service is broadcast every fifteen minutes and is received by a large group of pagers at the same time.

A pager must be assigned to the same POCSAG address code, also called a

capcode, to receive the page at the same time. Moreover, use of a common group code allows the carrier to transmit the message only once, which

Marion is manager of pager engineering at NEC America's Mobile Radio Division, Richardson, TX. Lewis serves as manager of trials implementation for the Worldwide Wireless Strategy Group of BellSouth Enterprises in Atlanta. The NEC Provider and Courier pagers are examples of alphanumeric pagers that use the POCSAG operation described in this article to support group information services.

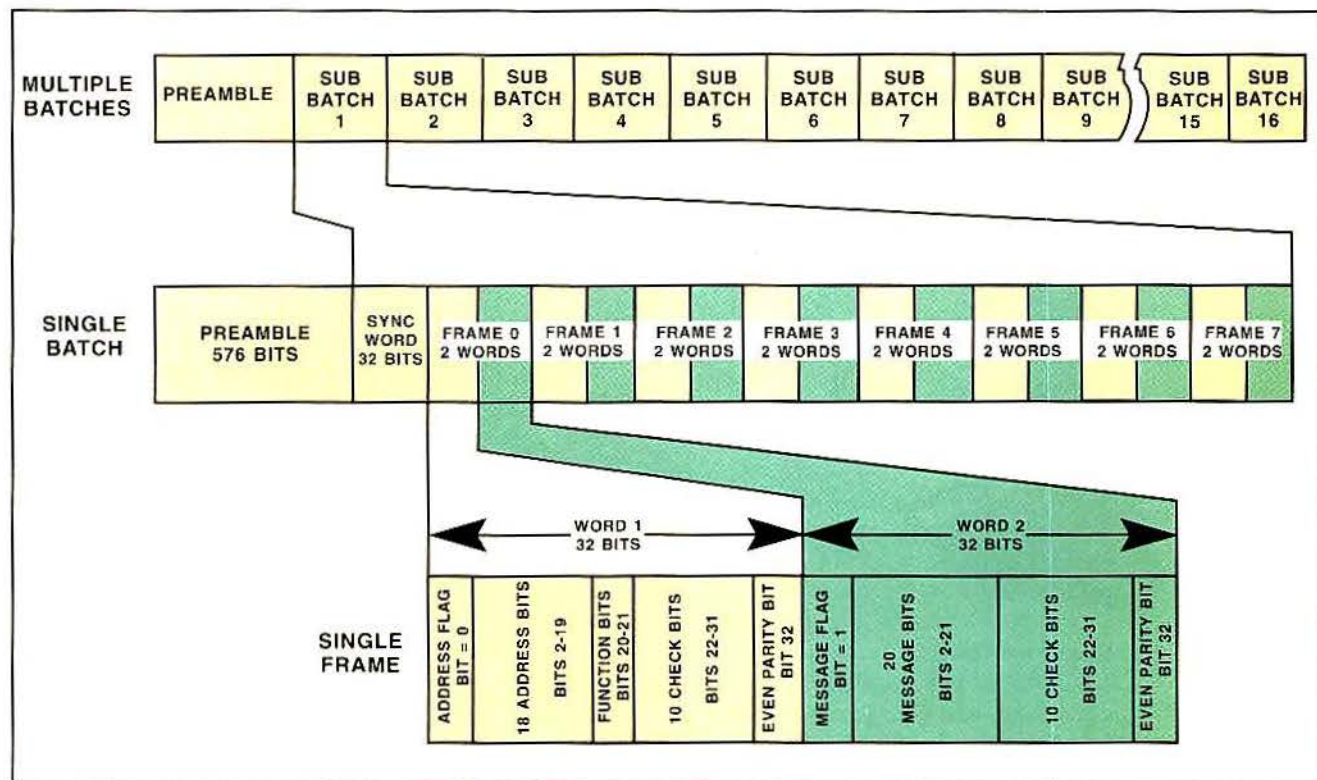


Figure 1. A POCSAG code transmission is composed of a preamble, a synchronization code and a minimum of eight frames numbered from 0 to 7. One frame consists of two 32-bit words. Many batches may be sent in a single transmission by inserting a synchronization code at the end of every batch until the final batch is reached.

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Carriers often face difficulties when setting up a large group of pagers to receive information services on a common group address code, or capcode. Most of the difficulties can be organized into two major categories: problems inherent in POCSAG¹ group code assignment and

selection of appropriate solution.

POCSAG description

Before code assignment difficulties can be addressed, a background description of the POCSAG code itself is required.

There are 2,097,152 possible POCSAG addresses.² Twenty-one bits are required to represent all possible

POCSAG code addresses. At least three significant bits of the 21-bit address code are stripped from the code and used for frame assignment of a transmitted pager address.

A POCSAG code transmission is composed of a preamble, a synchronization code and a minimum of eight frames numbered from 0 to 7. One frame consists of two 32-bit words.

Many batches may be sent in a single transmission by inserting a synchronization code at the end of every batch until the final batch is reached. (See Figure 1 on page 10).

Of primary significance to information service group code assignment is the POCSAG frame. POCSAG is composed of frames because of its inherent *time division* operation.

In the time division coding scheme, the POCSAG pager, upon detecting the preamble and "waking up" from the battery-save mode, will turn on for only one of the eight time frame periods. The time-division method conserves battery life because the pager is required to be in the ON state for only $1/8$ of the total batch transmission time.

Frame assignment

How does a pager know to which frame it is assigned?

Frame assignment is a function of the pager's address code. A transmitted POCSAG address code is 32 bits long. Eighteen bits are used for the actual address code.

The remainder of the 32 bits are used for error check bits, address flag, function bits and parity bits. (See Figure 1.) Three additional bits are derived by the pager's frame assignment.

The three frame assignment bits, along with the 18 bits transmitted to the pager, produce one of the 2,097,152 possible paging addresses.

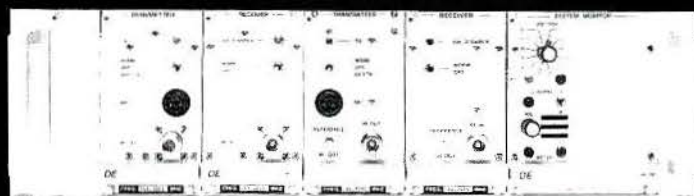
The concept of frame assignment bits is a little abstract and bears further explanation.

An identical 18-bit address code can be transmitted in each of the eight frames, but it represents eight different pager addresses. A pager assigned to frame zero does not respond to the address codes in other frames.

In other words, the pager only responds to a matching address word in its own frame. This frame is assigned

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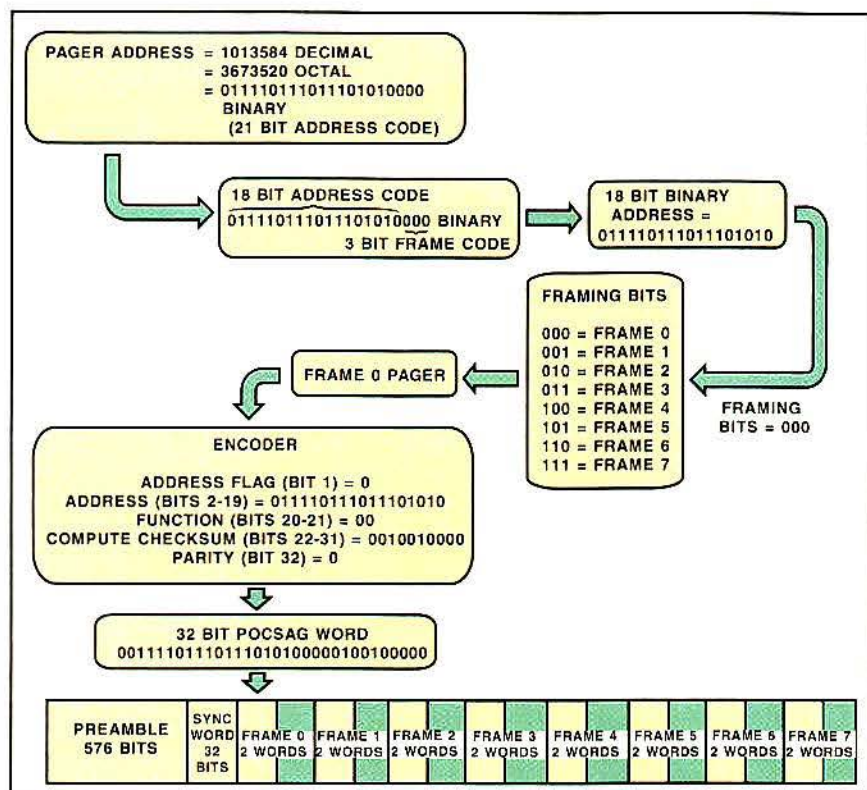


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to the pager when it first is programmed with its address. All 21 bits of the address paging code are used during this programming.

The pager calculates its frame assignment using the three least significant code bits mapped as the three binary bits to frames 0 to 7. (See Figure 2 to the left.)

Code assignment

Because a pager uses the address code to determine when to turn on during a POCSAG batch, and further, because a pager is allowed to turn on only once during each batch, it follows that if more than a single code is as-

Figure 2. The pager calculates its frame assignment using the three least significant code bits mapped as the three binary bits to frames 0 to 7. The three bits that are removed from the address code are not transmitted by the terminal, and the pager pays no attention to them other than to determine its correct frame. The pager then turns on during the frame that corresponds to the 3-bit frame assignment number.

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signed to the pager, all assigned codes must fall within the same frame.

Because of the fundamental POCSAG limitation in multiple code frame assignment, the carrier must be aware of methods for identifying the frame in which an address code belongs and how to assign additional codes to the same frame.

Two methods are used to determine a POCSAG frame: the chart method and the calculator method.

The chart method uses the frame chart displayed in Figure 3 on page 18. The chart method uses the following three easy-to-use steps:

1) Find the last three digits of the POCSAG address code assigned to the pager.

2) Locate the three digits from step one on the frame chart. The address code is assigned to the frame corresponding to the number of the column in the frame chart.

3) Any additional POCSAG codes assigned to the pager must use codes whose ending three digits match those

in the corresponding frame column found in step 2.

The frame chart makes clear an important characteristic of POCSAG

*If pagers are assigned
common group call codes,
the individual paging
addresses must be
separated by eight or a
multiple of eight . . .*

codes that are assigned to the same frame. All numbers read from a single column, and therefore found within the same frame, regardless of ascending

or descending order, are separated from each other by eight or a multiple of eight.

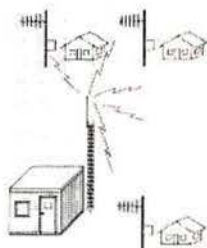
For this reason, all pagers that are assigned POCSAG common group call codes must have all of the individual codes in the group separated from each other by eight or a multiple of eight. This "quirk" in the assigning of POCSAG group call codes is quite different from the typical daily experience of simply assigning codes by incrementing by one the last code assigned on the system.

Perhaps the single biggest difficulty encountered in assigning POCSAG group call codes for an information service is the failure to recognize this difference between standard code assignment and the "eight or multiple of eight" rule for group calls.

If pagers are assigned common group call codes, the individual paging addresses must be separated by eight or a multiple of eight, not the usual "increment by one" rule for standard code assignment.

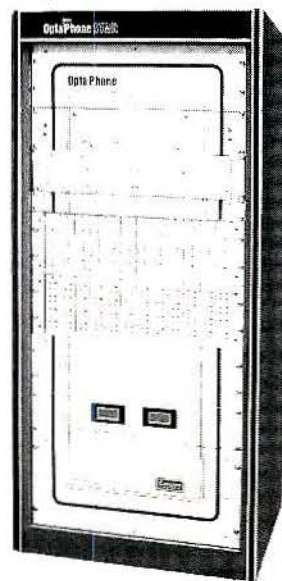
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Figure 3. The chart method for determining a POCsAG frame uses these steps: 1) Find the last three digits of the POCsAG address code assigned to the pager. 2) Locate the three digits from step one on the frame chart. The address code is assigned to the frame corresponding to the number of the column in the frame chart. 3) Any additional POCsAG codes assigned to the pager must use codes whose ending three digits match those in the corresponding frame column found in step two.

POCSAG FRAME							
0	1	2	3	4	5	6	7
000	001	002	003	004	005	006	007
008	009	010	011	012	013	014	015
016	017	018	019	020	021	022	023
024	025	026	027	028	029	030	031
032	033	034	035	036	037	038	039
040	041	042	043	044	045	046	047
048	049	050	051	052	053	054	055
056	057	058	059	060	061	062	063
064	065	066	067	068	069	070	071
072	073	074	075	076	077	078	079
080	081	082	083	084	085	086	087
088	089	090	091	092	093	094	095
096	097	098	099	100	101	102	103
104	105	106	107	108	109	110	111
112	113	114	115	116	117	118	119
120	121	122	123	124	125	126	127
128	129	130	131	132	133	134	135
136	137	138	139	140	141	142	143
144	145	146	147	148	149	150	151
152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167
168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183
184	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199
200	201	202	203	204	205	206	207
208	209	210	211	212	213	214	215
216	217	218	219	220	221	222	223
224	225	226	227	228	229	230	231
232	233	234	235	236	237	238	239
240	241	242	243	244	245	246	247
248	249	250	251	252	253	254	255
256	257	258	259	260	261	262	263
264	265	266	267	268	269	270	271
272	273	274	275	276	277	278	279
280	281	282	283	284	285	286	287
288	289	290	291	292	293	294	295
296	297	298	299	300	301	302	303
304	305	306	307	308	309	310	311
312	313	314	315	316	317	318	319
320	321	322	323	324	325	326	327
328	329	330	331	332	333	334	335

POCSAG FRAME							
0	1	2	3	4	5	6	7
336	337	338	339	340	341	342	343
344	345	346	347	348	349	350	351
352	353	354	355	356	357	358	359
360	361	362	363	364	365	366	367
368	369	370	371	372	373	374	375
376	377	378	379	380	381	382	383
384	385	386	387	388	389	390	391
392	393	394	395	396	397	398	399
400	401	402	403	404	405	406	407
408	409	410	411	412	413	414	415
416	417	418	419	420	421	422	423
424	425	426	427	428	429	430	431
432	433	434	435	436	437	438	439
440	441	442	443	444	445	446	447
448	449	450	451	452	453	454	455
456	457	458	459	460	461	462	463
464	465	466	467	468	469	470	471
472	473	474	475	476	477	478	479
480	481	482	483	484	485	486	487
488	489	490	491	492	493	494	495
496	497	498	499	500	501	502	503
504	505	506	507	508	509	510	511
512	513	514	515	516	517	518	519
520	521	522	523	524	525	526	527
528	529	530	531	532	533	534	535
536	537	538	539	540	541	542	543
544	545	546	547	548	549	550	551
552	553	554	555	556	557	558	559
560	561	562	563	564	565	566	567
568	569	570	571	572	573	574	575
576	577	578	579	580	581	582	583
584	585	586	587	588	589	590	591
592	593	594	595	596	597	598	599
600	601	602	603	604	605	606	607
608	609	610	611	612	613	614	615
616	617	618	619	620	621	622	623
624	625	626	627	628	629	630	631
632	633	634	635	636	637	638	639
640	641	642	643	644	645	646	647
648	649	650	651	652	653	654	655
656	657	658	659	660	661	662	663
664	665	666	667	668	669	670	671

POCSAG FRAME							
0	1	2	3	4	5	6	7
672	673	674	675	676	677	678	679
680	681	682	683	684	685	686	687
688	689	690	691	692	693	694	695
696	697	698	699	700	701	702	703
704	705	706	707	708	709	710	711
712	713	714	715	716	717	718	719
720	721	722	723	724	725	726	727
728	729	730	731	732	733	734	735
736	737	738	739	740	741	742	743
744	745	746	747	748	749	750	751
752	753	754	755	756	757	758	759
760	761	762	763	764	765	766	767
768	769	770	771	772	773	774	775
776	777	778	779	780	781	782	783
784	785	786	787	788	789	790	791
792	793	794	795	796	797	798	799
800	801	802	803	804	805	806	807
808	809	810	811	812	813	814	815
816	817	818	819	820	821	822	823
824	825	826	827	828	829	830	831
832	833	834	835	836	837	838	839
840	841	842	843	844	845	846	847
848	849	850	851	852	853	854	855
856	857	858	859	860	861	862	863
864	865	866	867	868	869	870	871
872	873	874	875	876	877	878	879
880	881	882	883	884	885	886	887
888	889	890	891	892	893	894	895
896	897	898	899	900	901	902	903
904	905	906	907	908	909	910	911
912	913	914	915	916	917	918	919
920	921	922	923	924	925	926	927
928	929	930	931	932	933	934	935
936	937	938	939	940	941	942	943
944	945	946	947	948	949	950	951
952	953	954	955	956	957	958	959
960	961	962	963	964	965	966	967
968	969	970	971	972	973	974	975
976	977	978	979	980	981	982	983
984	985	986	987	988	989	990	991
992	993	994	995	996	997	998	999

LAST THREE DIGITS OF SEVEN-DIGIT POCsAG CODE

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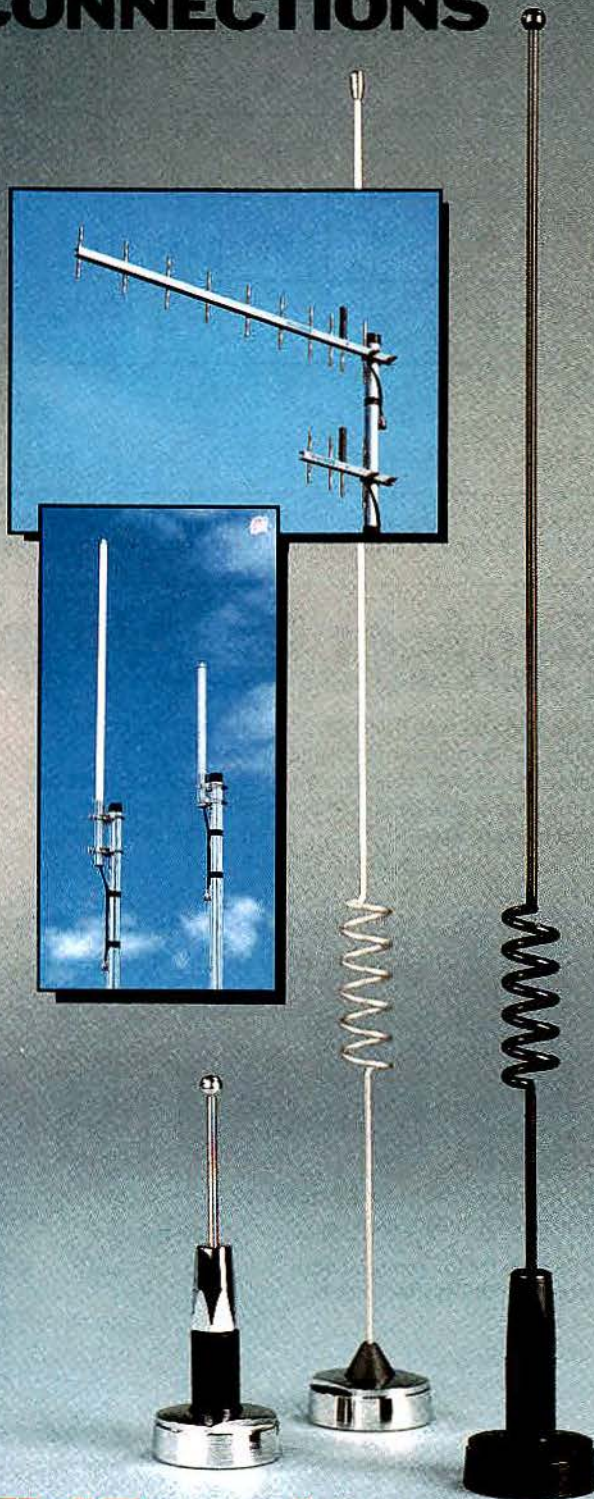
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4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Figure 4. The frame chart in Figure 3 lends itself quite well to a calendar analogy described in the text to explain the "eight or a multiple of eight" rule.

The frame chart lends itself quite well to an analogy often used to aid in explaining the "eight or a multiple of eight" rule. This is the *calendar analogy*. (See Figure 4 to the left.)

The calendar for April 1993 is in Figure 4. Imagine that a given task must be scheduled for every Thursday in April. Beginning with Thursday, April 1, every Thursday of the month is separated from the first Thursday by seven days or a multiple of seven days—that is, April 8, April 15, April 22 and April 29.

The analogy with the POCSAG frame chart becomes clear when each day in the month is thought of as one of seven time slots or frames. The primary difference is that POCSAG uses eight frames instead of seven. When we take an overview of a month, the "seven or multiple of seven rule," and, similarly, the POCSAG "eight and a multiple of eight rule" no longer are difficult.

The calculator method for determining a pager's POCSAG frame uses the

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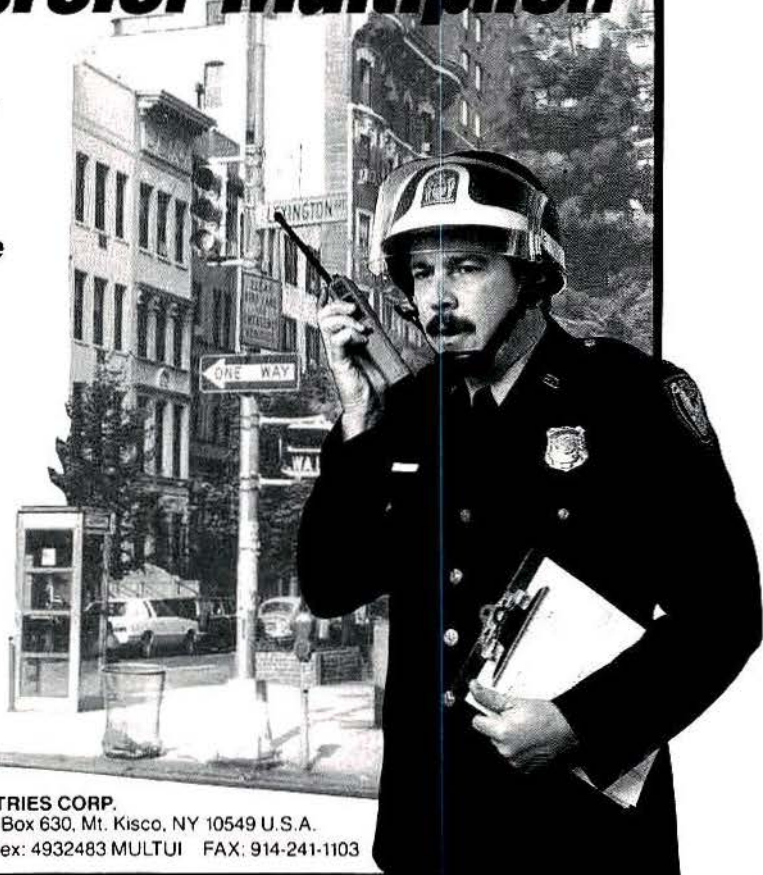
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following steps:

1) Enter the POCSAG address code into the calculator. (Actually, only the last three digits of the capcode are required, but for simplicity, there is no harm in entering the entire code.)

2) Divide the capcode by eight.

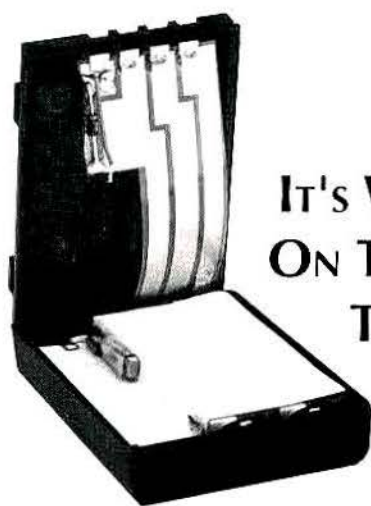
3) Take the remainder (remainder only—those digits to the right of the decimal point) and multiply by eight.

4) The resulting number is the number of the POCSAG frame to which the pager is assigned.

Because a remainder is involved in the calculator method, those with a flair for mathematics may compare POCSAG code frame assignments by dividing the address code by eight and comparing remainders. POCSAG frame assignment can be found by

matching the remainders as given below:

Frame 0: No remainder
Frame 1: Remainder = .125
Frame 2: Remainder = .25
Frame 3: Remainder = .375
Frame 4: Remainder = .5
Frame 5: Remainder = .625
Frame 6: Remainder = .75
Frame 7: Remainder = .875



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A second calculator method for determining a pager's POCSAG frame uses the base number conversion feature found on many newer calculators. The following steps can be used:

1) Enter the POCSAG address code into the calculator in base 10. (Again, only the capcode's last three digits are required.)

2) Follow the directions supplied with the calculator and convert the number from step one above to octal (Base 8).

Once POCSAG and its group call assignment and framing characteristics are understood, one must know the best place to begin when assigning codes . . .

3) The last number of the results is the POCSAG frame number assigned to the pager.

Practical example

Once POCSAG and its group call assignment and framing characteristics are understood, one must know the best place to begin when assigning codes to a large group of pagers. As with POCSAG frame determination techniques, it is best to follow a step-by-step approach as follows:

1) *Reserve a large block of codes to be used for the information service group population.*

Remember, because all individual codes must be separated from each other by eight or a multiple of eight,

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the block of codes must be larger than what normally is required when standard codes are assigned one by one. Presumably, the block of codes between every eighth code could be assigned to other pagers, although tracking the "leftover" codes can be complicated and most likely would require the aid of a computer program or spreadsheet.

2) Assign group codes first.

Assume that a block of 10,000 codes ranging from 0100024 to 0110023 is selected.

If, for example, three group codes are needed, choose the first three codes falling within the same frame. (The first three were chosen for the sake of simplicity. Any three codes within the same frame could be selected.)

By inspection, using the frame chart, the first code is in frame 0, the second code falling within frame 0 is 0100024 + 8 = 0100032, and the last code is 0100040. The three group codes within the same frame are:

Group Code 1: 0100024
Group Code 2: 0100032
Group Code 3: 0100040

Individual codes now must be selected. Individual codes are required because it always is assumed that subscribers require an individual paging code for personal pages in addition to any information service group codes that are required.

3) Assign individual codes.

The easiest way to assign individual codes is to begin at the highest group code and count up by eights to ensure that all codes remain in the same

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The easiest way to assign individual codes is to begin at the highest group code and count up by eights to ensure that all codes remain in the same frame.

frame. Assuming a group of 200 pagers, the code assignments would begin at 0100048 and continue upward by eights until 0101640 is reached.

Alternative group call methods

Despite the complexity of POCSAG group call assignment, group calls traditionally have been assigned using the procedures described above. Although there are other methods that minimize the difficulty of code assignment, each of them, in one way or another, affects system operation.

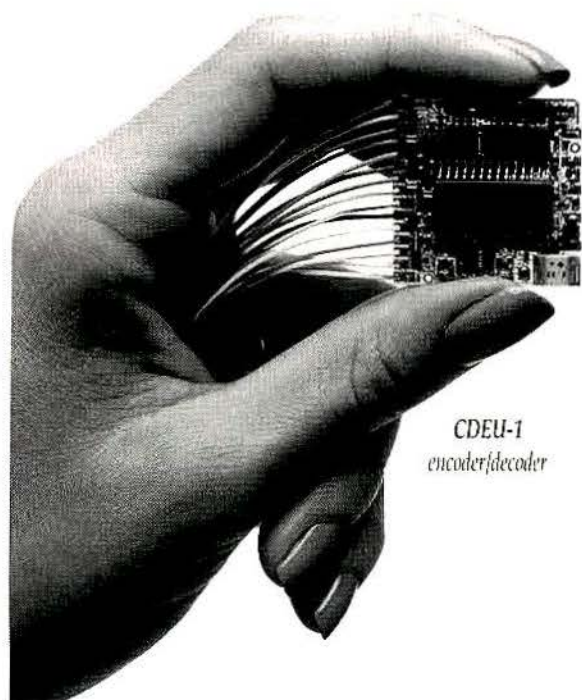
Terminal Group Call

Instead of transmitting a single page

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that is received simultaneously by multiple users, most paging terminals can transmit multiple pages in rapid-fire succession to simulate reception of simultaneous pages. This feature does not come without cost.

A terminal usually is programmed to perform this function by assigning a dummy number that references a large subscriber list within the group. Unfortunately, when the number is called, the terminal spends a great deal of time searching for subscribers in the group list and processing the pages.

Once the terminal assembles the entire pager list, each individual pager is sent a separate page. The process consumes considerably more airtime. The excessive processing time this feature requires and the unnecessary waste of airtime required to page each pager generally rules out terminal group paging in most systems.

'Hybrid' group call

The hybrid group call method of transmitting a group call has some

characteristics of both terminal group call and standard, single-code group call.

In this case, instead of using one or

*Once the terminal
assembles the entire pager
list, each individual pager
is sent a separate page.*

*The process consumes
considerably more airtime.*

more common group codes, eight codes are assigned throughout the entire pager population. Each of the eight group codes corresponds to a different POCSAG frame.

Because all POCSAG frames are used, assignment of individual codes using the "eight or multiple of eight" rule is not required.

This method greatly reduces the code assignment burden, but it comes with a large cost.

Each information service page must be transmitted eight times to reach the entire pager population. Nevertheless, compared to the terminal group page, the hybrid method becomes more efficient when there are more than eight pagers assigned to a group.

The hybrid method may have some utility when sending brief messages to the entire pager population, such as when a carrier might advertise some new service offering.

The airtime cost is prohibitive, though, when the longer messages typical of most information services are transmitted.

Dual-frame operation

The POCSAG code structure is designed for operation within a single

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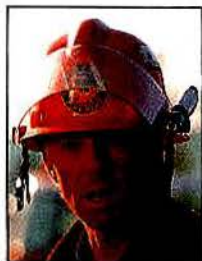
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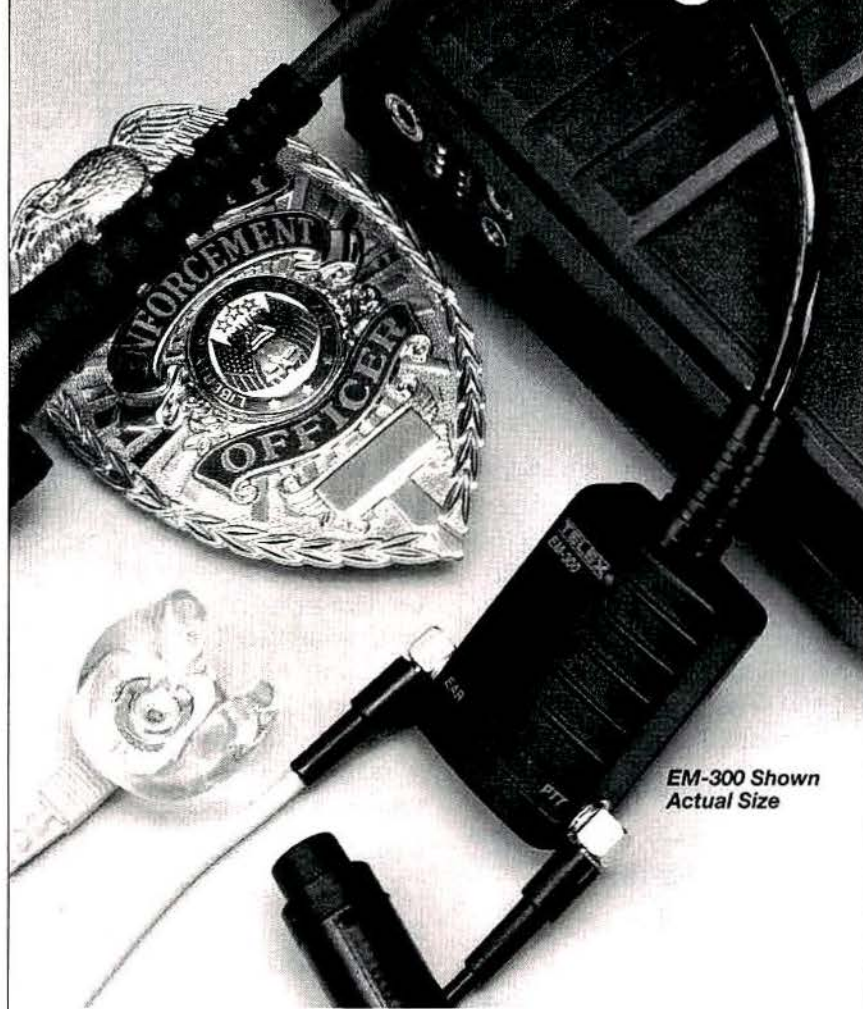


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frame. Single-frame operation is understood in the POCSAG specifications, even though it is not absolutely required.

If a pager is allowed to operate in more than one frame, group call code assignment is greatly simplified at the expense of approximately 10% to 20% of battery life. This percentage figure translates to approximately two or three days, in most cases. This period is an estimate only, because pager battery life calculation is complicated. (See *MRT*, May 1991 for a detailed explanation of battery life calculation.)

At least two models of alphanumeric pagers are capable of this new POCSAG operation.

Group codes must be assigned to fall within the same frame, although indi-

Single-frame operation is understood in the POCSAG specifications, even though it is not absolutely required.

vidual codes may be assigned at will. This procedure eliminates the burden of tracking large groups of codes that follow the "eight or multiple of eight" rule.

Furthermore, the increased efficiency of code assignment and tracking is obtained with a loss of battery life that is not objectional and, in most cases, virtually unnoticeable.

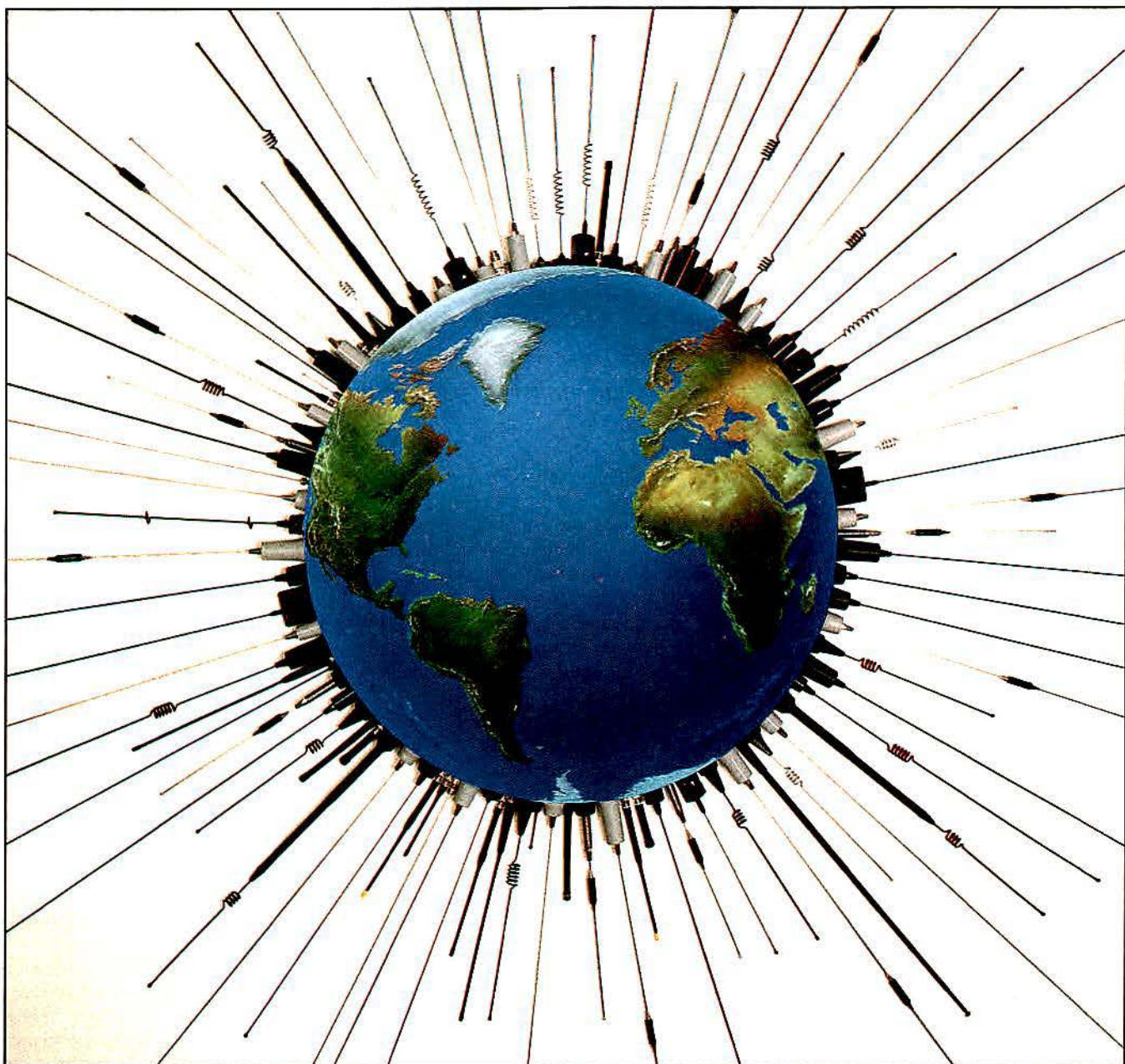
Whether a traditional group call assignment method or one or more of the alternative methods is used, a good understanding of POCSAG group code assignment limitations greatly aids in the smooth introduction of group information services.

References

1. POCSAG is the most widely accepted digital paging code in the United States. Of the nearly 14 million pagers in service, it is estimated that the vast majority are POCSAG pagers.

2. The actual number of usable addresses is somewhat less than 2,097,152 because of problems with specific bit patterns.





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Using SINAD voting combiners in mobile radio networks

SINAD voting systems improve wide-area coverage on common channels. Voting frees operators from selecting zones and channels. Diversity reception can improve performance.

By A.O.J. Woodfield

Traditional land mobile radio systems include communications among a dispatcher at a fixed location and operators who use various mobile and portable units.

The base station might be installed at the fixed location where dispatching takes place. If that location is unfavorable for radio coverage, the communications range may be limited.

Woodfield is manager of Uni-Lab New Zealand, Christchurch, New Zealand. When this article was written, he was systems manager at Tait Communications, Christchurch.

The base station might be installed at a more favorable location and remotely controlled from the dispatch location to improve coverage.

The system may use a repeater station on a high building or geographic feature to relay communications throughout a fairly large area.

When even greater range is required, two or more repeaters may be connected by radio links, microwave links or telephone lines to combine their coverage areas. Linking allows all members of a fleet to monitor and use a common audio channel. Such systems usually require the mobile users to select the appropriate channel for the area in which

they are located. Because the correct channel may not be immediately obvious to users traveling across many different repeater coverage areas, it is not uncommon to find many incidents of lost calls or poor communications because users select the wrong channel.¹

Mobile receiver scanning is one way to solve the problem. The scanning receiver switches automatically from channel to channel until a signal is found. Unfortunately, a simple scanner locks onto any received transmission, not necessarily on the best available channel.

Another solution is to use quasi-synchronous transmission methods in which all transmitters, controlled by highly stable oscillators, broadcast simultaneously on a common channel.² Quasi-synchronous transmission is expensive, and its maintenance requires great care and relatively expensive test equipment.

Mobile voting

A mobile voting system includes receiver scanning, but with an important addition: When a signal is received on any of the scanned channels, the mobile scans once more through all of the other channels and measures the received signal strength on each one. It selects the channel with the strongest signal.

The process requires a fast mute response time in the mobile and a fast signal strength measuring capability. A typical mobile scanning five channels may require 450ms (milliseconds) to complete the cycle before receiver audio is switched on. It takes about 50ms per channel to unmute; another 30ms per channel to measure the signal

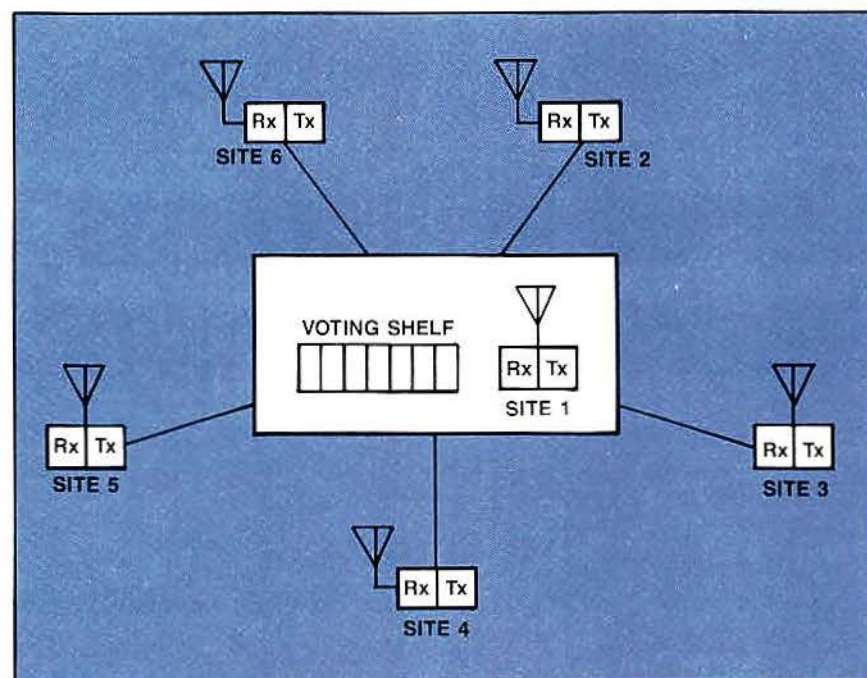


Figure 1. In the more common star network, satellite receivers are placed throughout the coverage area. They feed signals to a centralized voting shelf.

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strength; and another 50ms to compute the result, select the channel and unmute again to allow the operator to hear the message. Until then, the audio output remains silent.

When continuous-tone controlled squelch system (CTCSS) is involved, the process takes more time. If the detection of a valid tone is left until the last stage in the process, it may increase the

delay by 100ms to 200ms for a 650ms delay. For a system with CTCSS and 10 channels, a second may elapse before audio is heard, a delay that is unacceptable to most operators.

Some mobile voting systems require the permanent presence of transmitter carriers to operate properly. Such a requirement is inefficient, and it creates a potential source of interference.

Another problem with these wide-area coverage systems is the rapid rise in channel requirements. In many cases, the greater channel numbers can result in significantly reduced channel loadings and a consequential rejection of channel requests by local regulatory authorities.

The increasing use of portable transceivers adds problems for the network designer. Although a hand-held receiver's sensitivity may approach that of the usual mobile receiver, the lower transmitter output level, typically 5W (+37dBm), coupled with the lower efficiency of a shortened, helical antenna, results in significantly reduced portable coverage. To cope, system designers may add fill-in repeaters with additional linking, adding to the channel and linking requirements.

For larger networks, link channel requirements can be substantial. If UHF radio links are used, basic equipment design limitations, such as audio signal-to-noise performance and distortion figures, can limit the number of possible links.

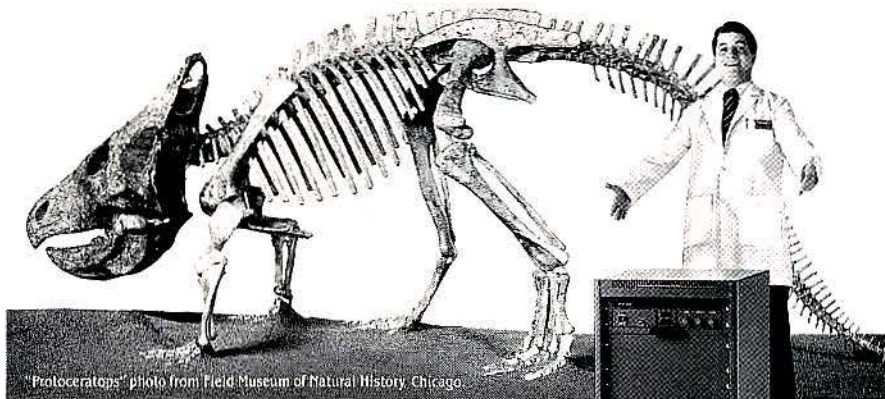
SINAD voting

SINAD voting systems offer a solution. They help to cover a wide area with multiple radio channels; reduce RF channel and linking requirements; and support selective signaling, data transmission and CTCSS in much the same way they are used in conventional repeaters.

The SINAD voting system continuously measures received audio from receivers within the coverage area. The SINAD of all of these audio signals, usually represented by a fluctuating dc voltage, is passed to a comparator. The comparator analyzes all valid incoming signals. The best signal is selected and fed to the transmitter or transmitters covering the desired area.

The best channel selection may be made either on a continuous—almost syllable-by-syllable—basis, or on a once-per-transmission basis. The once-per-transmission mode may be desirable for sites that cover low-signal-level areas where communication with mobiles otherwise may be lost when received SINAD levels are consistently low. This mode may be desirable, moreover, when data transmission is involved

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because frequent phase changes in received signals would be undesirable.

Network configurations

Two basic SINAD voting system configurations are available to the system designer, the star and the linear-spur.

► **Star network**—Figure 1 on page 30 shows the more common star network, in which satellite receivers are placed

throughout the coverage area. They feed signals to a centralized voting shelf. This central site may include the transmitter for the coverage area and another receiver, but this is not essential.

The links may be wireline or radio, and they may use tone-on-idle or E/M signaling to indicate receiver gate operation.

Selected audio may be passed to a

control room or to the local transmitter for repeater applications. If the system transmitters are located around the coverage area, the voted audio can be selectively routed to them or passed to all transmitters. A word of caution: If multiple transmitters are used simultaneously on identical frequencies and if their coverages overlap, quasi-synchronous simulcasting must be used to avoid problems associated with frequency drifts and offset.³

► **Linear-spur**—Figure 2 on page 36 shows the linear-spur network. It resembles the star network and is more appropriate for covering long-and-thin-shaped areas, such as highways and railways. The figure shows coverage along a highway.

Remote base stations feed their signals to a central control room via three voting systems operating in series. With this scheme, any mobile can access the system anywhere along the highway using a common, single mobile transmitter frequency, and all mobiles use a common receive frequency. The voters automatically retransmit on the correct transmitter or on a transmitter specifically selected by the central control room operators.

SINAD voter operation

On the test bench, SINAD measurements normally are simple to make. A 1kHz test tone modulates the RF test generator, and the receiver's audio output level is measured two ways: directly and through a sharp, 1kHz notch filter to give the SINAD value. Nonetheless, when only normal speech or signaling is present, measuring SINAD is more difficult.

One method that represents the various schemes available in commercial voting systems is shown in Figure 3 on page 38. Each incoming received audio signal is amplified logarithmically, increasing low-level signals and providing less gain for high-level signals. This stage is followed by an envelope detector that detects the gain-limited audio delivered by the previous stage.

The valley detector then measures the difference between the detected audio signal's peak, corresponding to the SIGNAL + NOISE + DISTORTION component of a SINAD measurement system and the signal's valleys, which correspond to the

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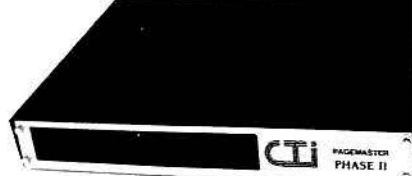
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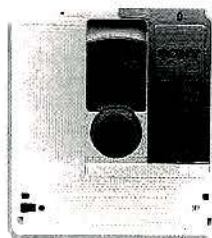
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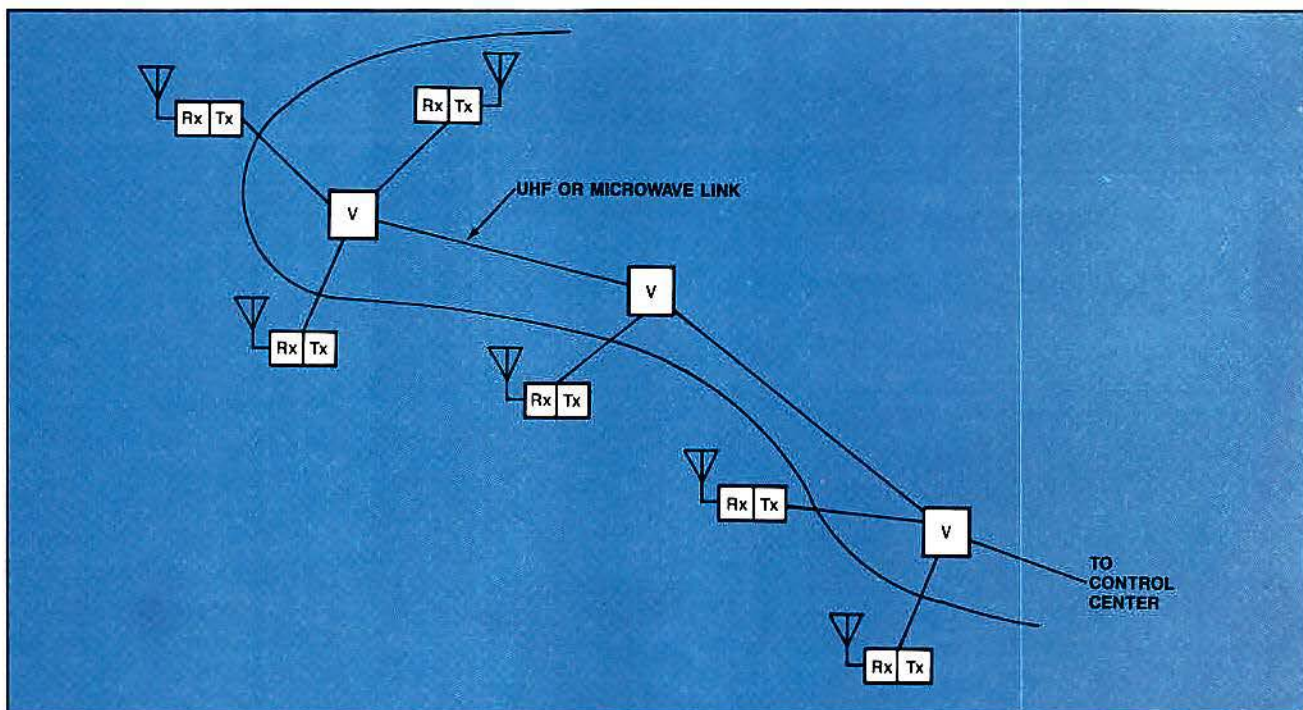


Figure 2. The linear-spur network resembles the star network. It is more appropriate for covering long-and-thin-shaped areas. In this example, a highway system's remote base stations feed signals to a central control room via three voting systems operating in series.

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Glendale W.T. Rx	Cheviot	Engineers	Miami Heights
Comm Center	Comm Center	Glendale W.T.	Calhoun Hall
Loveland W.T. Rx	Mt. Echo	Calhoun Hall	Greenhills
Sweetwine Rx	Miami W	Comm Center	Loveland W.T.
Anderson Tap Rx	Greenhills		Mt St Joseph
Greenhills Vote	Cleves		Sweetwine
Engineers Rx	Fernald		Miami W
Milford	Prov. Hosp.	Fire Channel 11	Glendale W.T.
Maricmont Rx	Mt St Joseph	Repeater Ctrl Dis	Maricmont
Calhoun Hall	Engineers	Comm Center	Milford
	Miamitown	Indian Hill Rx	Cheviot
	Harrison	Miami Heights Vote	Cleves
		Calhoun Hall	Williamson Rd
		Engineers Rx	Prov. Hosp.
			Fernald
			Mt. Echo Fail
			Engineers
			Miamitown

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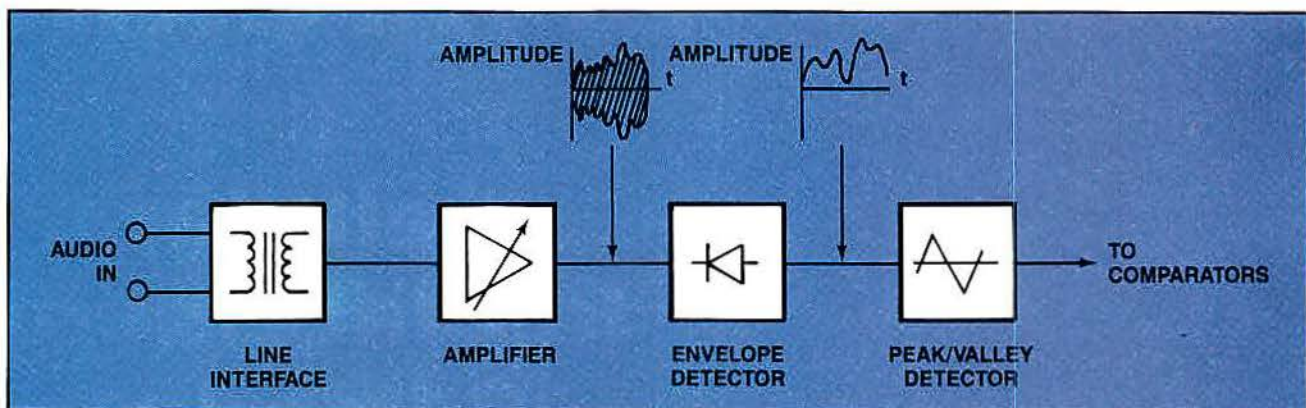


Figure 3. In this configuration of a commercially available voting system, incoming received audio signals are amplified logarithmically. An envelope detector detects gain-limited audio delivered by the previous stage. The valley detector measures the difference between the detected audio signal's peak, corresponding to the SIGNAL + NOISE + DISTORTION component of a SINAD measurement system and the signal's valleys, which correspond to the no-signal NOISE + DISTORTION of SINAD. The resulting dc output of this difference-detector then represents the instantaneous received SINAD.

no-signal NOISE + DISTORTION of SINAD. The resulting dc output of this difference-detector represents the instantaneous received SINAD.

This brief overview ignores some highly critical areas of the various circuit blocks, especially the important dy-

namic range constraints, the required system signal timing and the decision logic that surrounds these stages to ensure that only valid signals are analyzed and passed to the comparators.

It is essential that no audio compression or limiting occurs in the receiver

audio stages or intermediate linking equipment prior to being presented to the voter for analysis. If compression or limiting occurs, then the log amplifier may limit or amplify the low-level signals excessively. The following envelope detector stage may then limit, and the

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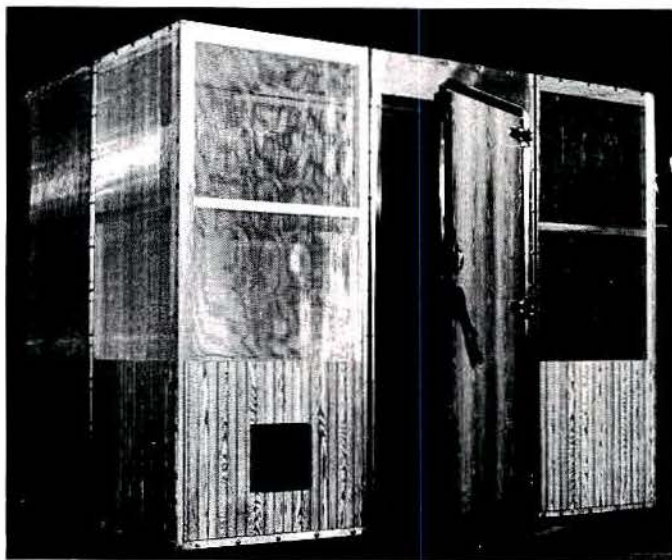
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The total system is small and compact, weighing less than 200 pounds (91 kg).

The photo shows the base unit, the zone (microcell) unit, and the two 14-inch (356 mm) dish antennas.

A complete system alarm is included.

Installation

The base unit can be housed at the host cell site while the zone unit can be mounted on a utility pole, billboard or building at the microcell site.

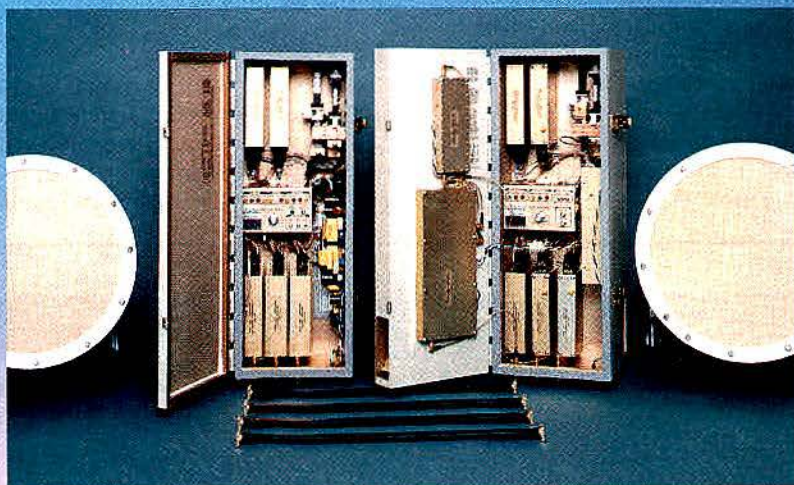
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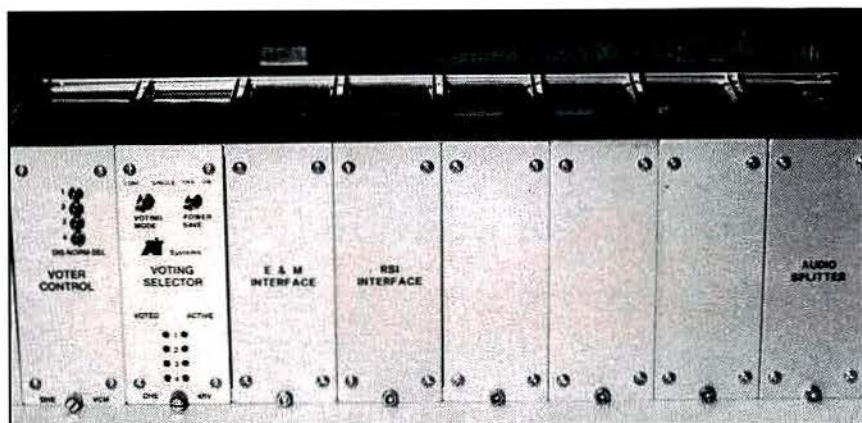
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Circle (37) on Fast Fact Card



A UHF diversity rack shows two monitored UHF shelves (top) and a voting system for diversity combining of the two UHF receivers on the UHF shelves.

resulting response of the valley detector may indicate a poor SINAD for that channel. If the channel is limiting badly, this situation inadvertently may indicate the truth—that a bad-quality signal is being received—but for the wrong reason.

Other SINAD measurement techniques adopted in SINAD voter equipment attempt to avoid the problem through the

use of window detection and other methods, but all systems can be affected badly by gain limiting and compression.

Time constraints

Fast voting system operation is crucial to successful radio system operation, especially if selective calling or data transmissions are to be used. Excessive delays in decision logic require

the user's mobiles to adopt lengthy lead-in delays prior to sending selective calling (selcal) or data transmissions. In the latter case, the lead-in delay can lead to extremely poor overall system performance, even with the best high-speed data terminal equipment. If the system must wait for 500ms before the transmission channel is ready, for example, a five-digit selcal sequence at 20ms per tone, which usually takes 100ms to 150ms to send, will require 600ms to 650ms to achieve the same result.

Decision logic

Decision logic must ensure that only valid received signals enable the SINAD voter detectors and faults such as lost or disfunctional audio lines are able to be cleared automatically by detection circuits and timers, or manually, if required. For example, the detectors almost invariably see valid channels that have no audio signals as having the best SINAD because noise and distortion on faulty lines is extremely low. This problem can be avoided with tone-on-idle

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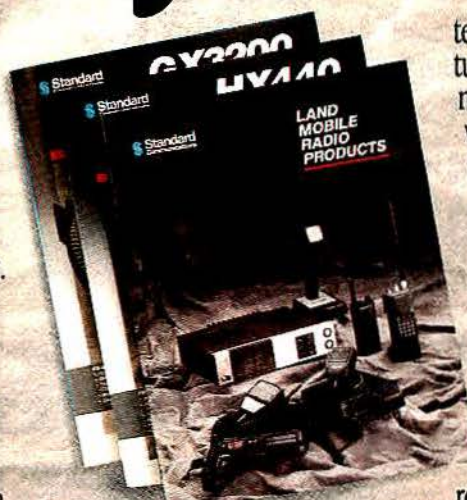


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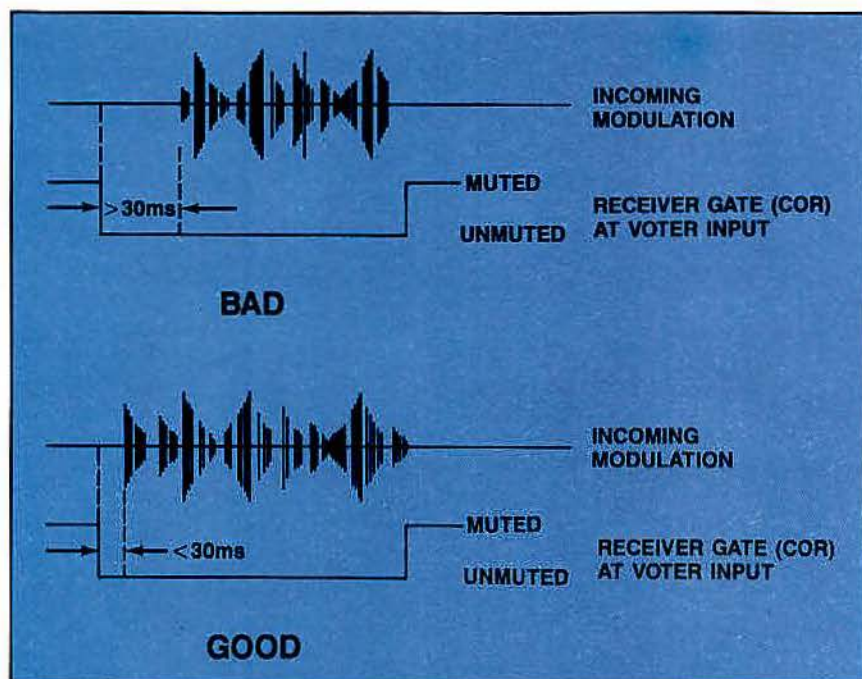


Figure 4. If selective calling or automatic number identification (ANI) signals are sent at the beginning of transmissions, the selcal and ANI data will be partially or completely missed if erroneous timing occurs. The drawing shows examples of good and bad gate signal sequences.

signaling timeout timers, hard-wired E+M lines or similar methods.

Timing

It is essential to ensure that signaling applied to the voter is timed correctly. In particular, a receiver gate signal must not arrive before valid audio arrives. If it does, the voter automatically selects the channel with the receiver gate signal and remains on it until audio arrives at the inputs. Then it makes a proper selection.

If the voter time constraints provide hysteresis to hold a selected channel for a nominal 200ms (normally, an acceptable period), it may take 250ms to select a correct channel following an invalid selection based on the early arrival of a receiver gate signal.

If selective calling or automatic number identification (ANI) signals are used in such a system, and if they are sent at the beginning of transmissions, then the selcal and ANI data will be missed partially or completely if erroneous timing occurs. Figure 4 on the left shows

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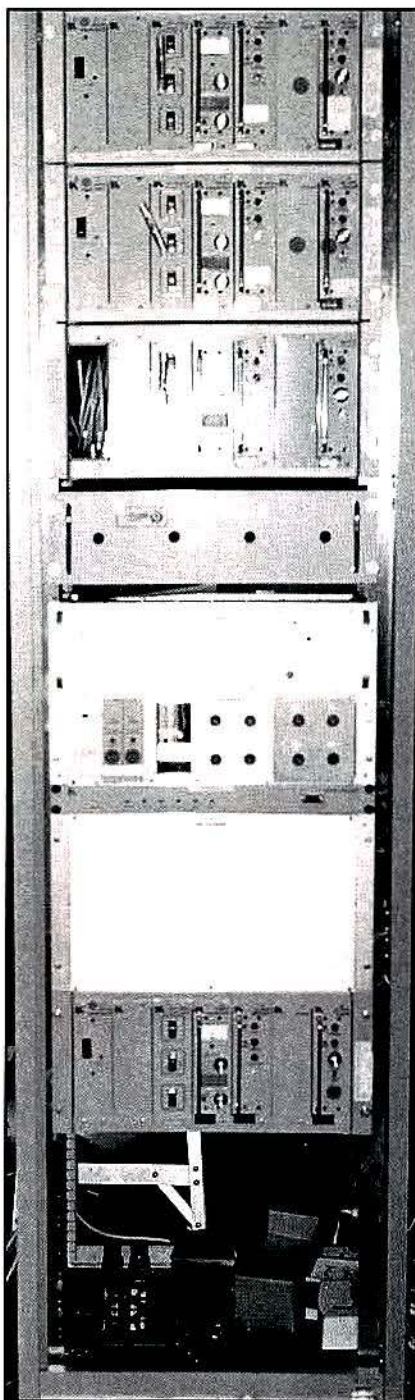
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A typical four-channel SINAD voting system shelf with an optional four-wire E/M wire interface, received SINAD indicator (RSI) interface and an audio splitter for audio retransmission.

good and bad examples of gate signal sequences.

The use of CTCSS signaling within voting systems is one example in which such timing sequences can be experienced, and careful design checks must

be made to ensure correct operation. System alignment must be handled carefully to ensure that all factors are checked.

Frequency response

Where several voting systems are set up in series, as in the linear-spur configuration, the system frequency response is composed of the sum of the individual equipment frequency responses. If voters are in sequence, and if each has a 300Hz-to-3,000Hz, ± 3 dB frequency response characteristic, the output from a series of three such systems will exhibit a 9dB rolloff at 300Hz and 3,000Hz. This is not the way to engineer a professional sound on a mobile network.

It is important to keep edge rolloff and in-band ripple to a minimum. In networks designed by the writer, the specification adopted is 300Hz to 3,000Hz ± 0.2 dB. A simplex frequency response tailoring network is added to each voter to ensure that the specification is met. With five such voters in series, the network output should be better than ± 1 dB across the frequency range.

System alignment

The following describes a typical alignment sequence for a voting network. It is essentially valid for almost all system configurations.

(1) All outstation radio equipment should be aligned and tested fully, and correct line levels should be set. If outstations use CTCSS tones, they should be checked, and the modulation levels should be measured.

(2) Align and test radio linking equipment, especially where CTCSS regeneration is to occur. Where fixed lines are to be used, they should be tested to ensure that they are noise-free and that their frequency responses are correct.

(3) Align and test the voting shelf, initially using a SINAD voter alignment test set if available and using valid system audio line levels.

Do not use continuous audio tones for SINAD voter testing and alignment because continuous tones do not provide the audio detectors with the necessary peak-and-valley sequences. SINAD voter test sets provide gated tones that partially simulate speech or signaling. The



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gated tones allow correct alignment and permit operation to be tested fully. A proper test set lets the voter be tested completely and independently of the networks and allows network problems to be isolated more rapidly.

(4) Check the SINAD voter shelf for at least 3dB hysteresis between channels to ensure that minimal interchannel selection "chatter" occurs in service

when mobiles present nearly equivalent SINAD inputs to multiple receivers. Hysteresis of more than 6dB should be avoided to ensure that smooth interchannel selection occurs within the voter. Signal acquisition time should be less than 50ms after receipt of a valid gate signal, and channel hysteresis should provide a hold time of about 200ms. Shorter hold times produce excessive

"chatter," and longer times delay valid channel selections.

(5) Check audio output levels from the voter and the presence of a valid transmitter key signal when a valid receiver gate input is received.

(6) Test the signal/gate timing between each outstation and the inputs to the voter shelf. Use a modulated RF signal generator as a source for the receiver, whose RF output is gated slowly on and off (at two-second intervals, for example), and observe (using a storage os-

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Shorter hold times produce excessive "chatter," and longer times delay valid channel selections.

cilloscope at the voter) the arrival of the receiver gate signal and the received modulation. Modulation may precede slightly or be coincidental with the gate signal, but it must not be more than 20ms or 30ms behind the arrival of a valid receiver gate signal. Check that no modulation gaps occur during the switching between receivers on a common shelf.

(7) Check the audio level at each transmitter site to ensure correct modulation levels are maintained. If at all in doubt, check the link or line audio frequency response to ensure an optimum audio response is present—preferably better than ± 1 dB at the band edges for any individual audio path.

Other voter system uses

► **Diversity**—SINAD voting systems can be used for receiver diversity applications. Diversity techniques improve the communications path between mobiles and the base stations by combining multiple signals and reducing the periodic deep fading that occurs when mobiles move about the coverage area.

Space diversity improves the received

(continued on page 78)



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For additional information, contact David Allen or Rex Reed at



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The COM-120A

1993

IMCE/Spring show preview/guide

Welcome to *Mobile Radio Technology's* preshow coverage of the 1993 International Mobile Communications Expo/Spring. Our editors have worked to provide a comprehensive overview of the annual mobile communications show. This section is designed to help you to plan your time at

the show at the Anaheim Convention Center, Anaheim, CA, March 23-25.

Sections include:

- a pull-out map on page 48A, which includes an exhibitor list and exhibitors' booth numbers.
- a summary of exhibitors' products and services on display. Exhibi-

tors listed include those who submitted information as of press time.

More than 300 mobile communications equipment manufacturers, distributors and service providers will convene at the Anaheim Convention Center, and many exhibitors will debut new products and services as they gear up for 1993. Products on display will include antennas, accessories, cellular items, mobile data communications, mobile and portable radios, paging equipment, test equipment, tone signaling equipment, towers and other communications-related items.

For a rundown on what exhibitors plan to unveil and showcase at this year's event, refer to the products and services section beginning on page 50. The names of advertisers in this issue are highlighted in blue ink. Page number cross-references provide quick reference to their respective advertising.

In addition to the new products exhibitors will display in their booths, there will be a "New Products Introduction Center." Here, visitors may review new products.

Symposiums will cover mobile communications topics and explore communications requirements and possibilities. Topics will focus on FCC regulatory actions, international mobile markets, technology updates, mobile data and mobile communications developments.

To make the most of your time on the show floor, use the pull-out map on page 48A for guidance. It lists exhibitors and booth numbers. Booths are clearly outlined and aisles are numbered to make it easy to find specific booths. Take the map to Expo.

Mobile Radio Technology will be in booths 451 and 453. See you at Expo!



Event: International Mobile Communications Expo/Spring

Dates: March 23-25

Location: Anaheim Convention Center

City: Anaheim, CA

Number of Exhibitors: More than 300

Projected Attendance: 5,000 to 8,000

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Wednesday, March 24, 9 a.m. to 6 p.m.

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Seminar Schedule: Tuesday, March 23, 8:30 a.m. to 4:45 p.m.

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See ad page 310 **Circle 900**

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 On-Glass IV antenna; Border Patrol signal management/call steering/data collection device for cellular systems; connector sleeve for weather protection; 220MHz-222MHz antenna system equipment including hybrid and low-loss combiners; filters; duplexers; mobile and base antennas.
Circle (356) **See ad on IFC**

Antenna World **Booth 239**
Existing products
 UHF, 800MHz, 900MHz, cellular, mobile, marine and portable antennas; coaxial cable and connectors.
New products
 CLR-32 series glass-mounted antennas.
Circle (357) **See classified ads**

Antennas America **Booth not assigned**
Existing products
 Disguised mobile antennas.
New products
 Tunable antennas.
Circle (358)

Applied Spectrum Research **Booth 1062**
Existing products
 Radio design utilities (R.D.U.); radio system planning techniques (RSPT) 5.2; radio system design software (RSDS); lattice.
New products
 Lattice 3.0; radio system planning techniques 5.3.
Circle (359) **See classified ads**

APREL **Booth 1281**
Existing services
 Independent product evaluation and certification services; radio, cellular, antennas, telecom; R&D; engineering and consulting services; electromagnetics/RF, grounding and shielding, ESD and transients; acoustics and electroacoustics performance; network and communications standards.
Circle (360)

Automation & Electronics Engineering **Booth 639**
Existing products
 MLS (multi-line select) series consoles; RT series tone remotes; RD series dc remotes; DTMF and 1,500Hz dial pulse encoders and decoders.
New products
 MLS series consoles featuring as many as eight lines or base stations that can be simultaneously monitored. Console can be dc or tone controlled.
Circle (361) **See classified ads**

Avcom of Virginia **Booth 1166**
Existing products
 PSA-65A, PSA-37D, PSA-35A portable spectrum analyzers; SDM-42A spectrum display monitor; microwave components and satellite receivers.
New products
 NASA-1000A network and spectrum analyzer; SDM-42 spectrum display monitor; MSG-1000B microwave sweep generator.
Circle (362)

Avtec **Booths 1337, 1339**
Existing products
 Advanced concept communications exchange and signaling system (Access) with color touchscreen activated, integrated radiotelephone console systems.
Circle (363) **See ad page 26**

Bally Engineered Structures **Booth 1268**
Existing products
 Equipment shelters constructed of modular insulated panels.
Circle (364)

Band-It—IDEX **Booth 1555**
Existing products
 Band-It ties; Multi-Lok ties; Tie-Lok ties.
New products
 ID-400 ID tagging system.
Circle (365)

Bee Electronics **Booths 205, 207**
Existing products
 Leather cases and accessories for portable two-way radios, cellular phones and pagers.
New products
 Leather cases to fit: Radius P110 radio, Maxon SP2000 series radio, Johnson Scorpion radio, ICOM ICU28 series radio and Nokia 101 portable cellular phone.
Circle (366) **See ad page 64**

Information for listings and booth numbers is accurate as of press time and is printed as provided. It is subject to change.

Shift Your Line of Thinking.



Today's business world is a race. If you want more profits, you need to shift your line of thinking to IDA — an industry leader in dealer service and product liability. IDA offers state-of-the-art LTR NETWORKING systems, along with the industry's most widely-used AIR-TIME BILLING system. Call us toll-free, right now, to learn more about our line of profit building products.

RLC

Stand-alone logic tray with advanced features.

RIC 2000

LTR compatible interconnect with dial-up networking and companding.

SYSTEM 3 PLUS

Airtime data collection and remote validator.

DID 1200

Direct Inward Dialing convertor.

ATBP

Easy to use Airtime billing software with long-distance capability.

NETLINK

Multiple customer/Multiple site dispatch networking for LTR.

EASYLINK

Low-cost single customer dispatch networking for conventional and/or LTR.

BETTER IDEAS COME FROM

IDA

IDA CORPORATION 1345 Main Avenue • Fargo, North Dakota 58103

Circle (48) on Fast Fact Card

For More Information Call Toll-Free

800-726-7477

Bendix/King Mobile Communications

Booth 460

Existing products

VHF, UHF and 800MHz portable radios; VHF and UHF mobile radios; dual transceiver mobile; signaling devices; accessories.

New products

E-series DES portables available in VHF, UHF and downband UHF.

Circle (367)

Bird Electronic Booths 1246, 1248

Existing products

RF power measurement instruments, including wattmeters and accessories.

Circle (368)

See ad page 72

Bomar Crystal Booths 405, 407

Existing products

Quartz crystals and batteries for two-way radios and pagers; channel element rebuilding on any frequency.

New products

Bravo Plus and Express 900MHz pager crystals.

Circle (369)

See ad page 60, classified ads

Bramco Booth 1537

Existing products

Mobile encoders, decoders, encoder and decoder; ANI; reed and active filters; 8-function controller; micro encoder and decoder.

New products

Model 3054 tower light monitor and reporter;

model 3056 mobile message center.

Circle (370) See ad page 44, classified ads

Buy-Comm-Co Booth not assigned

Existing products

Miscellaneous flyers dealing with buying and selling new and used radio equipment.

Circle (371)

See classified ads

Cadex Electronics

Booth 311

Existing products

C4000 series programmable battery analyzer; C6000 series modular battery analyzer.

New products

C3000 series programmable battery analyzer.

Circle (372)

Cal Crystal Lab

Booth 669

Existing products

Quartz crystals; crystal clock oscillators.

New products

HCMOS tri-state oscillators.

Circle (373)

See classified ads

Cartwright

Booths 1238, 1240

Communications

Existing products

Duplexers; cavities; wattmeters; power supplies; isolators; loads; cable connectors hardware.

Circle (374)

Cellular & Mobile

Booths 451, 453

International

Existing products

Mobile Radio Technology and Cellular Business

magazines jointly publish this bi-monthly magazine for the international marketplace. The publication, *Cellular & Mobile International*, focuses on key issues and developments pertinent to the mobile RF environment. The circulation of 10,000 predominantly reaches Africa, Australia, Central America, Europe, Far East, Middle East, New Zealand and South America.

Circle (375)

Cellular Business

Booths 451, 453

Existing Products

Cellular Business is the "Journal of Cellular Telecommunications." It is published monthly and provides marketing and engineering information and news of the cellular industry. Readers are cellular professionals, including dealers; agents; resellers; engineers; and members of the telecommunications financial and legal communities.

Circle (376)

Cellular Wholesalers

Booths 632, 634

Existing products

Distributor of AdvanceTec, Antenna Specialists, Audiovox, BEL, Canon, Centurion, Fujitsu, Hirschmann, Larsen, Maxon, Maxrad, Mitsubishi, Motorola, NEC, OKI, Ora, Panasonic, Pioneer, SMC, Technophone, Uniden and Valor.

New products

OkI 1150.

Circle (377)

INCE booth #404

TAIT base stations— as reliable as gravity.

An apple started Newton's thoughts on gravity's reliability. TAIT believes that base stations and repeaters should deliver that same sort of reliability. Our two-year warranty reflects that belief. Do others measure up?

● **Apples are equally easy to maintain**—just a polish now and then. TAIT modular radios, using industry-standard components, are no problem for any experienced tech.

● **Apples are discrete**—no interference. TAIT adheres to the highest noise immunity standards in the industry; standards radios built *only* for the U.S. can't meet.

● **Apples are compact**—with high value. Where other systems are refrigerator-size, we put a briefcase handle on TAIT repeaters. Call for more on:



**Radios reliable as
gravity in 80 countries**

1-800-222-1255

Fax: 713/468-6944

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Circle (49) on Fast Fact Card

NEW!

Page Maker™ 8



Big Terminal Features in a Small Paging Terminal

For Smaller Markets, Customer Owned Paging, Health Care or for those Special Alpha Applications

Unipage now offers those with smaller paging demands, a paging terminal that has many of the features normally found only on larger terminals. And it's affordably priced. Here are the standard features and some of the benefits that come with Page Maker 8.

Page Maker 8 Standard Features:

- 2000 Subscriber Number Capacity
- One Channel Output
- A Quad Store Card for Voice Paging
- A VP8 Card for Caller Prompting
- A Dual Trunk Card (two trunk inputs)

Profit from Big Terminal Features

- Use 2 Tone, 5 Tone, POCSAG 512, 1200 or 2400, GSC, NEC D3, NCA, or MBS pagers.
- Numeric, Alpha, Tone or Voice paging.
- Interfaces with PURC, Quintron and other transmitters.

A Few Benefits of Owning a Unipage

- Hot Card Maintenance--remove or install any card while the system is operational. It's convenient, and you don't have to power down and lose pages while the system is off the air.
- System is expandable to four trunks by adding an additional card. By adding other optional cards, your system can grow as your needs grow. And, all of the cards are transportable to an M15 chassis for future growth!
- Unipage is a Motorola company.

For more details, call Ron Walton at the Unipage number listed below. He will be happy to show you how the Page Maker 8 is the wise choice for your paging needs.



A Motorola Company

1510 N. Hampton
DeSoto, Texas 75115
(214) 228-5306
1-800-367-2864
FAX (214) 228-1430

Sold through Motorola Dealers or directly through Motorola and Unipage.

Circle (50) on Fast Fact Card

© Unipage, 1993

Sheer Genius

Celwave

Existing products

PD10183 10dB omni antenna; PD10216 120° 4.5dB sector antenna; PD10226 90° 5.5dB sector antenna; PD455 super StationMaster; PD220 StationMaster.

New products

Cellular bi-directional amplifier; PD10193 37° sector antenna; PD10222 variable H-panel antenna with downtilt bracket.

Circle (378)

Booth 442

See ad page 11

Central Tower

Existing products

Custom designed solid round member galvanized lattice, guyed and self-supporting towers and tubular monopoles for trunked and cellular communication systems.

New products

Series 5368 through 5729 "R" self-supporting towers; "L" guyed towers designed for 70mph-90mph winds.

Circle (379)

Booth 1345

See ad page 56

Centurion

International

Antennas and batteries for all types of communications equipment and specialized OEM applications.

New products

EXP series of 2.5dB injection-molded trunking portable antennas.

Circle (380)

See ad page 9

CES

Booths 313, 315, 317, 319, 321

Existing products

DTMF microphones; handsets; radiotelephone interconnects; status reporting systems; manual dialing 600L and 805 microphones; programmable 810 and 710 series microphones; ACI-35, HDI-68, RT1000, SDI-50, SSI-68, "personal patch," 5200 telephone interconnects; 3500, DID-50, RM10CA control products; status ID products; Bill Quick call accounting software.

New products

Lancer (local area network central exchange radio) trunking system; model 5400 controller, a programmable interconnect.

Circle (381)

CNet

Booth 204

Existing products

Solutions software; CNet's custom digitizing services.

New products

WiNGS workstation.

Circle (382)

Comm-Net 2000

Booth not assigned

Existing products

DG 200 programmable radio delay timer; DGRM 501 gated repeater maker; DGRM 501-B crossband/link repeater maker; DGME 1000 mobile extender.

New products

DG 200 programmable radio delay timer.

Circle (383)

Communications Associates

Booths 1356, 1358, 1360

Existing products

Cellular telephones and accessories; GE radios; test equipment; base station antennas; batteries and battery eliminators; portable facsimile machines; pagers.

New products

IFR communications service monitor COM-120A; Phonicell from Telular; series of 800MHz trunking antennas.

Circle (384)

See classified ads

Communications Engineering Technology

Booth 1456

Existing Products

Dial access for FCC information; engineering programs; intermod studies.

New Products

Coverage propagation studies and 3-D terrain programs.

Circle (385)

Communications Specialists

Booth 436

Existing products

Add-on tone signaling equipment for new and existing two-way radio systems—CTCSS, digi-



Receive only	Freq. Ranges (MHz)	N.F. (dB)	Gain (dB)	Comp. (dBm)	Device Type	Price
P30VD, P35VD, P40VD, P45VD	30-35, 35-40, 40-45, 45-50	<1.3	15	0	DGFET	\$ 44.95
P30VDG, P35VDG, P40VDG, P45VDG	30-35, 35-40, 40-45, 45-50	<0.5	26	+12	GaAsFET	\$109.95
P150VD, P160VD, P170VD	150-160, 160-170, 170-180	<1.5	15	0	DGFET	\$ 44.95
P150VDA, P160VDA, P170VDA	150-160, 160-170, 170-180	<1.1	15	0	DGFET	\$ 56.95
P150VDG, P160VDG, P170VDG	150-160, 160-170, 170-180	<0.5	24	+12	GaAsFET	\$109.95
P450VD, P460VD	450-460, 460-470	<1.8	15	-20	Bipolar	\$ 49.95
P450VDA, P460VDA	450-460, 460-470	<1.2	16	-20	Bipolar	\$ 74.95
P450VDG, P460VDG	450-460, 460-470	<0.5	16	+12	GaAsFET	\$109.95
P800VDG, P830VDG, P860VDG	800-830, 830-860, 860-890	<0.6	19	+12	GaAsFET	\$119.95
Inline (rf switched)						
SP30VD, SP35VD, SP40VD, SP45VD	30-35, 35-40, 40-45, 45-50	<1.4	15	0	DGFET	\$ 74.95
SP30VDG, SP35VDG, SP40VDG, SP45VDG	30-35, 35-40, 40-45, 45-50	<0.55	26	+12	GaAsFET	\$139.95
SP150VD, SP160VD, SP170VD	150-160, 160-170, 170-180	<1.6	15	0	DGFET	\$ 74.95
SP150VDA, SP160VDA, SP170VDA	150-160, 160-170, 170-180	<1.2	15	0	DGFET	\$ 86.95
SP150VDG, SP160VDG, SP170VDG	150-160, 160-170, 170-180	<0.55	24	+12	GaAsFET	\$139.95
SP450VD, SP460VD	450-460, 460-470	<1.9	15	-20	Bipolar	\$ 79.95
SP450VDA, SP460VDA	450-460, 460-470	<1.3	16	-20	Bipolar	\$104.95
SP450VDG, SP460VDG	450-460, 460-470	<0.55	16	+12	GaAsFET	\$139.95

Every preamplifier is precision aligned on ARR's Hewlett Packard HP8970A/HP346A state-of-the-art noise figure meter. RX only preamplifiers are for receive applications only. Inline preamplifiers are rf switched (for use with transceivers) and handle 25 watts transmitter power. Mount inline preamplifiers between transceiver and power amplifier for high power applications. System S/N Improvement 6-14 dB typical. Other amateur, commercial and special preamplifiers available in the 1-1000 MHz range. Please include \$2 shipping in U.S. and Canada. C.O.D. orders add \$2. Air mail to foreign countries add 10%. Order your ARR RX only or Inline preamplifier today and start hearing like never before!

Advanced Receiver Research

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Circle (51) on Fast Fact Card

POWER ON... with ASTRON.

Astron Corporation is the leading manufacturer of high-quality power supplies and converters for the land mobile industry.

With the new SL-11 series of low profile power supplies, specifically designed for base station applications, the setup is simple, easy and looks attractive. Just mount the radio, with the mounting pads (supplied with the power supply), to the top of the SL-11A (2 3/4" H x 7 5/8" W x 9 3/4" D) or the SL-11R (2 3/4" H x 7" W x 9 3/4" D). The power supplies are very well regulated and will provide 11 amps of current at a 50% duty cycle. The units have fold-back current limiting to protect them from overload and short circuit, and an overvoltage protection feature to protect the radio should the output voltage exceed a safe level. All SL series units are available in dark gray or black.

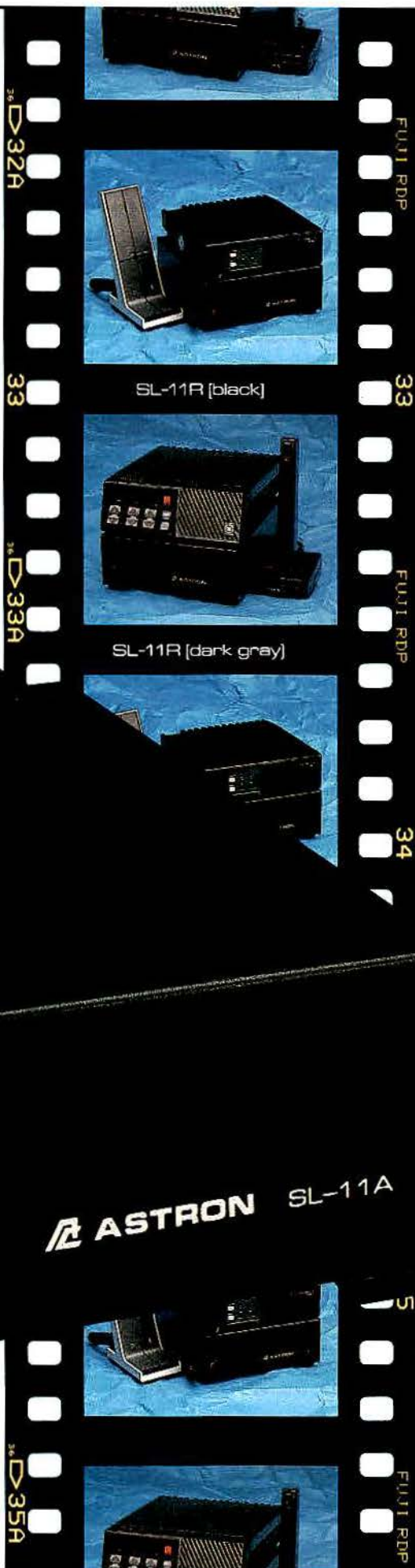
Power supplies and converters from Astron: our unsurpassed quality and reliability have made us the #1 choice in the communications industry.



ASTRON
CORPORATION

9 Autry, Irvine, CA 92718
Telephone: 714/458-7277
Facsimile: 714/458-0826

ASTRON SL-11A



SL-11R [black]

SL-11R [dark gray]

Expo

tal CTCSS (DCS), DTMF; paging encoders and decoders; repeater panels.

New products

ID-8 Morse code identifier, TS-64 miniature CTCSS encoder and decoder, DCS-23 miniature DCS encoder and decoder, PE-15 miniature POCSAG paging encoder.

Circle (386)

See ad on BC

Comsat Booths 1158, 1160 Mobile Communications

Existing products

Mobile satellite communications services via the Inmarsat system; services for portable briefcase and suitcase terminals; voice, fax, data, telex and high speed data services; Inmarsat-A, Inmarsat-B, Inmarsat-C and Inmarsat-M services.

Circle (387)

Com-Ser Laboratories Booth not assigned

Existing products

Service monitors.

New products

Emergency alert radios; "talking signs."

Circle (388)

Comtelco Industries Booth 570

Existing products

BSXL base station antennas; champion series yagi antennas; classic series mobile antennas; antenna-related accessories.

New products

BSXL 1.8GHz base station antennas; CC450,

CC800 coupler combiners.

Circle (389)

See ad page 64

Connect Systems

Booth 1032

Existing products

Models 700, 800, 8200 and 9800 interconnect; RT-8 rural telephone system; 6800 telephone and radio remote system.

New products

TP-154 shared repeater tone panel; CD-1 communications decoder unit.

Circle (390)

See ad page 13

CPI Communications

Booths 662, 664

Existing products

Dc and tone remote controls; dc and tone termination panels; remote control system for Radius M200 series and Maxtrac 300 series radios; remote control system for E. F. Johnson 8605 radios.

Circle (391)

See ad page 42

CTI

Booth 248

Existing products

Wec-Page; Mitec-Page; Page Master Phase II; DID/SMR 3-5 DID interface; SF-65 digital/analog store and forward; Mobile Master Phase II; Mobile Master Phase II RTX; TXC remote base station controller.

Circle (392)

See ad page 34

Cushcraft/Signals

Booth not assigned

Existing products

Mobile, base station and portable antennas for

30MHz-2,500MHz; broadband arrays, four poles, Ringo Rangers, unity gain, 3dB gain and 5dB gain mobile antennas; ultralink low-loss high temperature transmission line.

New products

Antennas for many spread spectrum applications at 900MHz and 2.4GHz.

Circle (393)

See ad pages 19, 34

D & L Wholesale

Booth not assigned

Distribution Center

Existing products

All Ericsson GE Mobile Communications products.

Circle (394)

See classified ads

DAPA

Booth 1454

Existing products

2900 series cell-site antennas.

Circle (395)

DataCom

Booth not assigned

Existing products

2WEL phone link; 2WFD phone link; 4WFD data link; SCADA RF network.

Circle (396)

See ad page 60

DataRadio

Booth 1332

Existing products

VIS turbo series 4,800bps mobile radio modems; COR series fixed, point-to-point and multipoint radio modems.

New products

VIS 24 series 2,400bps trunking and conven-

OUR COMPLEMENTS TO YOUR RADIO



OUR complete line of accessories enables use of portable or mobile radios in virtually any situation. We have extensive experience in solving communication problems — from the routine to the extremely difficult . . . and it's all available to you. Simply contact us.

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CORPORATION

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Mountain View, CA 94043
415/965-8020

Circle (53) on Fast Fact Card

Central to:

- Customer Needs
- Engineering
- Quality
- Fabrication
- Installation
- Specialized Services



Central to All Your Tower Needs

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Circle (54) on Fast Fact Card

2000 SERIES Paging Terminals

ZETRON

Log: I Found A Better Deal!

- Zetron's Model 2200, WITH:
- 3000 SUBSCRIBER, MEMORY
- 2 TELCO TRUNKS THAT SUPPORT VOICE, NUMERIC, AND ALPHA
- DETAILED TRUNK USAGE STATISTICS
- 1 CHANNEL OUTPUT
- INTEGRATED VOICE MESSAGING
- 6-Hour MIRACLEDISK DRIVES

ALL FOR UNDER \$17,000!

THIS ONE IS EXPANDABLE TO 32 TRUNKS, 4 CHANNELS, AND 50,000 SUBSCRIBERS. WE CAN ADD TAPP, CALL ROUTING, DIAL-OUT "MEET ME" PAGING.

CALL FOR THEIR CONFIGURATION GUIDE AT 206-820-6363
THANKS, BOB



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RCCs and PCPs



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Utilities Applications

ZETRON, INC.
12335 - 134th Court NE
Redmond, WA 98052-2433
(206) 820-6363 FAX: (206) 820-7031

Expo

tional mobile radio modems; Mobilmux mobile multiplexer for terminal, printer and GPS integration.
Circle (396)

David Clark Booths 754, 756

Existing products—Headsets with push-to-talk adapter cords for mobile and portable radios; voice activated headsets for portable radios; headset intercom systems with two-way radio interface.
New products—Series 4200 communication system.
Circle (397)

db Mobile Booth 112

Existing products—VHF, UHF, 800MHz, 900MHz and cellular mobile antennas; cellular accessories including batteries, eliminators, leather cases, mounts and portable antennas; ActiveLink repeater.
New products—Slim design articulating elevated-feed antenna.
Circle (398)

Decibel Products Booth 112

Existing products—Products covering 30MHz-1,800MHz frequencies; power amplifiers; metal base station; fiberglass base station; panel antennas; filter devices; microcell boosters and repeaters and other signal distribution systems; digital monitors.
New products—220MHz-222MHz antenna systems equipment

for narrowband technologies including hybrid and low-loss combiners, filters, duplexers, monitors and base station antennas.
Circle (399) See ad page 39

Diablo Communications Booths 435, 437

Existing products—Northern California antenna sites.
New products—Sites serving the Walnut Creek, Fairfield and Fresno areas.
Circle (400) See classified ads

Dinet Distributed Networks Booth not assigned

Existing products—Data-Mate mobile terminal system; MDT models 1000, 1500, 3100.
New products—DataMate 5000 central controller.
Circle (401)

DX Radio Systems Booth not assigned

Existing products—RTF series repeaters; RTP series portable repeaters; DXP and HMS series paging transmitters; RTD series radiotelephone links; Exicom series 835 and 9,800 VHF AM radios.
New products—800MHz and 900MHz repeaters and base stations; 900MHz paging systems; high performance repeaters and base stations.
Circle (402)

Dynatech Booths 348, 350

Tactical Communications

Existing products—SK-3, SK-5, SK-7, SK-9, R-4 two-way radio accessory security kits; EM-1 ear microphones; TM-2 throat microphones; PTT/VOX adapters, headsets.
New products—VOX mini-mic kit; TRAK/R-1000; Quick disconnect switch for MPA and MPD.
Circle (403)

Earmark Booth 1554

Existing products—Series 4 headset and belt-pak (wireless two-way radios); Voxset II Vox headphone for portable radios; Voxset Vox belt worn pack for portable radios; Loudmouth audio amplifier; Loudmouth Vox radio link radio interference for portable radios.
Circle (404)

EDX Engineering Booth 463

Existing products—SHDMP V5.0 wide-area coverage software; RPATH V6.1 point-to-point path profile software; CVR V1.1 contour plotting software; 3" and 30" terrain data on CD-ROM.
New products—MSITE V1.0 multiple site coverage analysis software; TPATH V1.0 advanced point-to-point path analysis software; SIGNAL V1.0 comprehensive propagation analysis package.
Circle (405) See ad page 82

YOU'LL FIND MORE THAN GREAT NAMES UNDER THIS ROOF

Convenient one-stop purchasing isn't all you get from Hutton. You can receive factory-caliber advice from a team that averages 14 years per person in your industry. You'll seldom experience a backorder because we maintain extremely heavy inventories. And we'll even deliver your rush order overnight when you call by 4 PM. Call toll-free to request a free fact kit.



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HUTTON HAS WHAT IT TAKES

Circle (56) on Fast Fact Card

With the new SLV40, what you see is less than what you get.



Actual size —
1.5" x 5.75" x 7"

Minimum Size, Maximum Punch!

What you see is the Mini-Com® Plus SLV40 from RELM Communications! It's the smallest, most compact mobile radio we've ever introduced.

But, what you get is a powerful, versatile radio that delivers all your basic communications needs with incredible ease of operation...all at the affordable price of only \$482.00!*

What more do you get? Just look at some of the features that will help make the SLV40 one of your best selling radios:

- 40 Watts of power for a strong, far reaching signal.
- Two-Tone Sequential is built-in...not an additional option.
- CTCSS and DCS (standard & inverted) are built-in, too!
- Two controls for easy operation — no push buttons or squelch knobs.

- 6 channel capability with bright, easy-to-read LED channel indicators.
- Rugged die-cast construction and surface mount device technology for outstanding durability and performance.
- A full complement of options, including DTMF capability.
- **Now with a 2 year parts & labor warranty!**

But, what if your customers want more? Fine. RELM offers the RSP Series portable radios and the RM Series mobile radios which have enough power, channel capability and additional features to satisfy the most ravenous high tech, power hungry appetite. And, all RELM radios carry our same firm commitment to quality.

So, when you need radios, call RELM Communications, Inc.

We've got the equipment you need!



The complete Mini-Com® Plus lineup also includes the PT Series* — PTV56 VHF and PTU46 UHF — portable radios and the SLU25* UHF mobile radio. These radios share the same features as the SLV40 and are available only from RELM Communications!

RELM
TM

COMMUNICATIONS
7707 Records Street
Indianapolis, IN 46226
1-800-821-2900



AN ADAGE COMPANY

* Manufacturers suggested retail price. Your price may vary. PT Series not for sale pending FCC approval.

Expo

E. F. Johnson

Booth 510

Existing products

Challenger UHF and VHF mobiles; Scorpion UHF and VHF handhelds; model 5876 conventional and UHF LTR handhelds; Challenger UHF LTR mobiles; model 8600 series LTR mobiles; model 856X series LTR handhelds; conventional, LTR and low-power industrial repeaters and telemetry modules.

Circle (406)

See ad page 45

EG&G Electro-Optics

Booth 1455

Existing products

FAA-approved aviation obstruction warning beacons and systems; FlashGuard 1000 white strobe; FlashGuard 3000 dual red-white medium intensity beacons.

Circle (407)

EMR

Booths 1004, 1005

Existing products

Isolators; load terminations; cavity resonators; antenna duplexers; hybrid-ferrite TX combiners; cavity-ferrite TX combiners; receiver multicouplers; antenna site consulting services.

New products

66500/BB series broadcast combiners; 66600/H enhanced power SMR combiners; 70000/CFHF series high-power ISO-CAVS; 7000/H and 8000/H series high-power isolators.

Circle (408)

Ericsson GE

Booths 612, 618

Mobile Communications

Existing products

Enhanced Digital Access Communications System (EDACS) equipment and radios; dual mode (EDACS and GE MARC trunked) mobiles and portables; conventional mobiles and portables.

New products

Monogram mobiles: MGM 148, MGM 160, MGM 450; Monogram portables: MGP 148, MGP 160, MGP 450; Orion mobile.

Circle (409)

ETrunk Systems

Booths 220, 222, 224

Existing products

Add-on trunking boards; ETR series mobile and portable trunking (UHF and VHF) radios; tone and tone/interconnect panels; programmers.

New products

ETR 2850 portable trunking radio; ETR 154 tone panel; ETR Star repeaters; ETrunk II all-band trunking/selective calling products.

Circle (410)

Fanon Courier

Booths 1142, 1145

Existing products

Courier Procom VHF and UHF FM handheld transceivers; Fanon megaphones; intercoms; P.A. amplifiers; paging systems; P.A. paging and talkback speakers.

New products

Courier Procom MU54 5W, 4-channel UHF FM handheld transceiver; Courier VRS M-2 Vox/

PTT headset and Vox control unit for hands-free communications for use with all Courier Procom handheld transceivers.

Circle (411)

Fibrebond

Booth 1462

Existing products

GFRC or custom manufactured portable telecommunications shelters; mobile (Cell on Wheels) communications system (complete/tower-installed); professional radio equipment installation services.

Circle (412)

Flash Technology

Booth 1361

Corporation of America

New products

ElectroFlash FTB 310 medium intensity obstruction strobe beacon.

Circle (413)

See classified ads

Freeman Engineering

Booth not assigned

Existing products

PVM series paging terminal with integrated voice services.

Circle (414)

See ad page 43

Fryer's Site Guide

Booth 667

Existing products

Fryer's Site Guide East edition; West edition.

New products

Mid-states edition; Southeast edition.

Circle (415)

See classified ads

"Paging Bomar Crystals!"



Bomar answers the call for excellence with high performance crystals designed for today's pagers. Our crystals are built to precise specs for totally clean, trouble-free reception, and won't drift .001 per cent in one year. We guarantee it. We also guarantee Bomar Crystals will outlive the pager. Check us out.

BOMAR

201 Blackford Avenue • Middlesex, NJ 08846

Call Toll-Free

1-800-526-3935

Fax Toll-Free

1-800-777-2197

Circle (58) on Fast Fact Card

EXCEPTIONAL WIRELESS TELEPHONE PRODUCTS

DataCom's PhoneLink/DataLink



DataCom Systems, Inc.



IDEAL FOR:

- Remote locations and sites
- Emergency communications
- Permanent or temporary services
- Mobile Phone communications
- Standard Range 450-470 MHz

OTHER PRODUCTS:

- 2WFD Phone Link \$3495⁰⁰
- 4WFD Data Link \$3495⁰⁰
- Above Units With Diagnostic Display \$4495⁰⁰
- RF Network SCADA, call for pricing

217-222-0160

217-222-0912 (FAX)

DataCom, Inc.

524 N. 30th St.

Quincy, IL 62301

Circle (59) on Fast Fact Card



We cater to those who want choice sites.

When you have an appetite for choice antenna sites in California, no one can cater to your tastes like Meridian and Diablo.

For more than three decades we've been serving a buffet of antenna sites that stretches from Chico to the Mexican border. Together, Meridian and Diablo offer you 73 tasty locations to choose from.

These sites are among the most sought after and unique in the country. Many are rich with features such as stand-by power, air conditioning, security, and all-encompassing maintenance programs. Many sites offer conventional and trunked community repeaters, as well as engineered and combined antenna systems.

Now Meridian and Diablo have four new antenna sites on the menu: Flint Peak in the Rose Bowl area, providing coverage of Pasadena, Glendale, Burbank and the San Gabriel and San Fernando Valleys; Smith Hill, which covers Concord, Lafayette and Walnut Creek; Vaca South, covering the Fairfield/Vacaville-Marysville-Stockton triangle; and an extraordinary site atop the International Trade Center which blankets the greater Fresno area.

When it comes to service, our qualified staff and caring approach to antenna site management will have you coming back for seconds.



Meridian Communications

23501 Park Sorrento, Suite 213A, Calabasas, CA 91302-1355
(818) 888-7000 • Fax (818) 888-2857



DIABLO COMMUNICATIONS, INC.

1220 Brickyard Cove Rd., Ste. 200, Point Richmond, CA 94801
(510) 236-3700 • Fax (510) 236-3799

Gamber-Johnson

Booths 925, 927

Existing products

Mounting hardware for any type of mobile voice and data communications equipment; air bag friendly mounts; MDTs, laptop, notebook and pen-based computers, radios; configurations for wide array of equipment in any type of vehicle.

New products

PCRadio Station docking station for IBM PCRadio; PalmReader docking station for GRiD PalmPad.

Circle (416)

General Communications Booths 500, 501

Existing products

Wholesale distribution of GE and Midland LMR mobile radios and accessories.

Circle (417)

See classified ads

Glenayre Electronics

Booth 226

Existing products

Advanced wireless communications products and services; radiopaging and voice retrieval systems; voice processing system; RF base station products for VHF, UHF and 900MHz stations.

New products

Model GLT8600 500W solid-state 900MHz paging transmitter.

Circle (418)

Hark Systems

Booth 504

Existing products

SI-550 DID interface; Trac telephone repeater audio card to enhance the audio on Motorola

SMR systems; Verifier paging decoder; CD100/Click detector to convert rotary into DTMF; AMT 2 mobile phone terminal; TAP 200 alphanumeric concentrator.

New products

Mega Switch high capacity digital switch for land mobile radio applications, DID interface, least cost routing and call distribution in T-1 and analog compatible switch platform.

Circle (419)

Hughey & Phillips

Booth 1156

Existing products

FAA-approved obstruction lighting, controllers and remote monitors for tall towers.

New products

Solid-state controller for dual-lighted tower with multiple strobe and red beacons.

Circle (420)

Hustler

Booth 502

Existing products

G6 series UHF verticals; G7 series VHF verticals; G series lowband verticals; SSM series mounts.

New products

HS9-45080 Spirit series UHF verticals.

Circle (421)

See ad pages 74, 75

Hutton Communications

Booth 937

Existing products

Distributor of more than 50 product lines including Andrew, Bird, Celwave and Decibel.

Circle (422)

See ad page 58

Hy-Q International

Booth 1283

Existing products

Quartz crystal products for communication; pager crystals; channel elements recrystallized; complete elements available; crystal filters; crystal oscillation.

Circle (423)

See classified ads

IDA

Booths 1038, 1040, 1042, 1044

Existing products

Netlink; Easylink; System 3; RIC 2000; V-2000, V-3000, V-3100 microphones; dc and tone remotes; companding board 4067 interconnect; 24-46 microprocessor-based dc remotes; 24-66 microprocessor-based tone remotes.

New products

20-27 tone remote adapter; 20-18 remote adapter panel; RLC controller; power supplies.

Circle (424)

See ad page 51

IFR Systems

Booths 457, 459, 461

Existing products

Communications service monitors and spectrum analyzers.

New products

COM-120A service monitor.

Circle (425)

See ad page 47

Industrial

Booth 1343

Telecommunications Association (ITA)

Existing services

A variety of spectrum management and telecom-

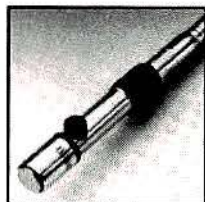
PEIKER



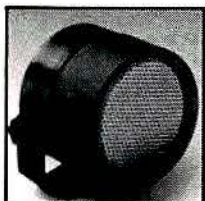
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COMMUNICATION IF YOU PREFER QUALITY...

HEAR WHAT YOU'VE BEEN MISSING ON THE SOUND PATH OF EXCELLENCE!



MICROPHONES (Goosenecks & Hand Mics) - deliver crystal clear transmission with hi cancellation of ambient noise



LOUDSPEAKERS - excel in difficult transmitting conditions (try our miniature, splashproof, flexible mounting model)

Ask about our miniature Speaker, Microphone Combination

OPTAC

QUALITY HEADSETS

WE OFFER SOLUTIONS:

CLEAR TRANSMISSION OF HUMAN VOICE Electret noise cancelling boom mic that eliminates ambient noise

MAXIMUM WEARING COMFORT

Lightweight design, wide, soft, skin friendly ear cushions

EASY DIALOGUE IN NOISY, HAZARDOUS ENVIRONMENTS

Noise reduction rating of 27dB



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ROPEX INC.

Circle (61) on Fast Fact Card

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Real Pagers for a Real World.



Today's pager customers come in all shapes and sizes.

They include plumbers, and business people and moms. Just regular folks who don't like being out of touch.

And when it comes to choosing pagers, they're looking for qualities that fit these practical times.

Like the ability to get the job done, without expensive gimmicks. And the solidness to endure the bumps and bruises of

a not-so-perfect world.

At Uniden, we've always designed our pagers with the real world in mind. So it's no surprise that as pagers become part of everyday life, Uniden is fast becoming the people's choice.

If you want to sell pagers to the no-nonsense customers of today, stock the pagers designed with the real world in mind. Uniden pagers.

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For more information about Uniden Pagers, Call 1-800-292-2294.
Circle (62) on Fast Fact Card

Expo

munications engineering services, including system/application engineering and technical studies. Formerly SIRSA.
Circle (426)

International Crystal Manufacturing

Booth 301

Existing products

Communications crystals 70kHz-200MHz; channel elements; oscillators; TCXO's; test oscillators; pagers; monitor pagers; talkback pagers; portable radios; repair service.

New products

Synthesized portable radios.

Circle (427)

See classified ads

JaBro Batteries

Booth 941

Existing products

Rechargeable NiCd batteries for two-way radios, cordless telephones, paging equipment, public safety, emergency lighting; charger/analyzer/conditioner systems for NiCd batteries.

Circle (428)

JB Communications of Watseka

Booths 1141, 1143

Existing products

Cellular cable assemblies, antennas, connectors, mounts and accessories.

New products

Nikolai leather portable and transportable cases.
Circle (429)

JEFA International

Booth not assigned

Existing services

Engineering and system design; system integration; path and frequency engineering; installation and maintenance service.

New services

Radio coverage analysis, frequency coordination.

Circle (430)

See classified ads

Kaval Electronics

Booth 1068

Existing products

800MHz, UHF and 800MHz repeaters; booster line amplifiers; tapped antenna; distribution systems.

New products

800MHz and 900MHz OFR HGM 8-0FR; taps for 50Ω cable.

Circle (431)

See ad page 77

Kenwood U.S.A.

Booth 1120

Existing products

Conventional portables, mobiles, base stations, repeaters; trunked mobiles, portables, and repeaters; options and accessories.

New products

TK-430 and 431 800MHz and 900MHz LTR format trunked portable radios; TKR-9300S 800MHz LTR format trunked repeater.

Circle (432)

See ad page 27

Leathersmith

Booth 1129

Existing products

Leather carrying cases for portable radios, pag-

ers and cellular phones.

Circle (433)

LeBlanc/L & R Communications Booth 1054

Existing products

Communications towers, field services; I&M, emergency restoration service.

Circle (434)

Lindgren Enclosures

Booth 747

Existing products

Radio frequency shielded enclosures and accessories.

Circle (435)

See ad page 38

Marconi Instruments

Booths 216, 218

Existing products

2955B radio test set; 2957B cellular test set; 6200 microwave test set for locating faults in coax and waveguide.

Circle (436)

Maxon America

Booth 922

Existing products

SP-2000 VHF and UHF synthesized handheld; SM-4000 synthesized VHF and UHF mobile; CP-0500 crystalized VHF and UHF handheld; SP-5050HD lowband synthesized handheld; ID POCAS VHF, UHF, 900MHz numeric pager; ND POCAS VHF, UHF, 900MHz numeric pager.

New products

TP-4800 800MHz trunking portable radio; SL-

COMTELCO INDUSTRIES, INC.

MC/MS Series Marine Antennas

Marine Cellular

27" 5dB Gain

\$33.00 ea

48" 6dB Gain

\$72.50 ea

VHF Marine

48" 3dB Gain

\$72.50 ea

Call For Free Product Data Book



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Quality Products Made in the USA since 1978

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Circle (63) on Fast Fact Card

BEETM Quality Leather Cases

We're working our hides for you!
Two-way / Cellular / Paging

We stock more quality top-grain leather cases than anyone else in the industry. Our manufacturing techniques match the advanced specifications of the latest in Portable Radio, Pager or Cellular models.

- Immediate delivery from large inventory.
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- Logo imprinting. ■ Low pricing.

If you're not getting this kind of service ... call today.



Your one-call supplier for Hard Protection and Soft Leather Cases.

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2655 Gardner Road, Broadview, IL 60153
Toll Free: 800/336-3115 Fax: 800/345-2091

Circle (64) on Fast Fact Card

The reason the ULTRA-COM 96DT is your best buy in a Desktop Radio Control Console is an inside story.

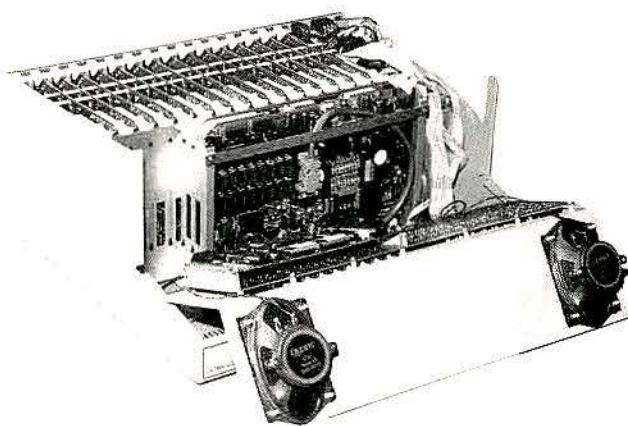
The ULTRA-COM 96DT's application of microprocessor technology and ergonomic console design provides all the features usually found in larger, more expensive systems.

But it's the *inside* story that makes the 96DT unique. All modules and components are readily accessible by simply removing the top cover and folding the front panel forward. Maintenance is a breeze.

The ULTRA-COM 96DT can be expanded to control up to 16 base stations by merely adding additional channel control modules.

The inside story includes:

- Intel's™ 8097 16-bit microcontroller
- Non-volatile EEPROM memory
- Programmable EPLD



System flexibility features:

- Individual call lights
- 2-4 and 6-wire control
- Phone patch
- Multiple site select
- Multiple frequency select
- Multi-format paging encoder
- Telephone/headset interface
- DC, tone and mux keying

Additional features and system expansion are easily incorporated with the exclusive, easy-to-use Programming Help Menus. These menus are available for system parameters, switch function, channel parameters and personnel/vehicle status.

Get the full story on "The Sensible Approach" to desktop consoles. Call or write for detailed literature and specifications.

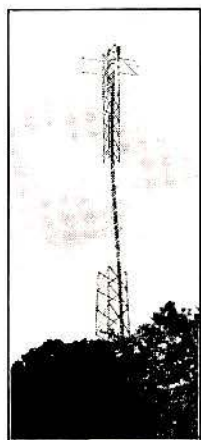


**MODULAR
COMMUNICATION
SYSTEMS, INC.**

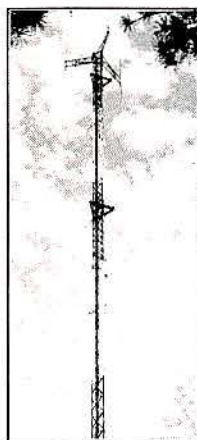
13309 Saticoy St, No. Hollywood, CA 91605 / (818) 764-1333 / FAX: (818) 764-1992

BOOTH NO. 1232

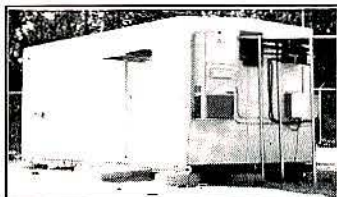
They're All Here!



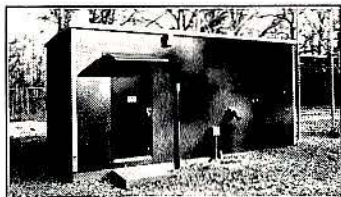
Self-supporting
towers



Guyed towers



Fiberglass shelters



Concrete shelters



Poles

**Over 45 years of quality products
for the communications industry**

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Circle (66) on Fast Fact Card

Expo

500 synthesized scanning handheld radio; SP-2000 DTMF keypad VHF, UHF.
Circle (437)

Maxrad Booth not assigned

Existing products—Antennas and related accessories; products for the land mobile, cellular and base station segments of the radio communications industry.

Circle (438) See ad page 23

Meridian Communications Booths 435, 437

Existing products—Space at 38 multi-use telecommunications antenna sites in southern California, including Mt. Lukens, Oat Mountain, Red Mountain, Saddle Park, Santiago Park, South Mountain, Sunset Ridge, Mount Wilson and Mount Woodson.

New products—Flint Peak antenna site in the Rose Bowl area of Los Angeles covering Pasadena, Glendale, Burbank and the San Gabriel and San Fernando valleys.

Circle (439) See ad page 61, classified ads

Micro-Quick Systems Booth 544

Existing products—Protocol sales, service, inventory, AR, point of sale software; E-XCEL telemarketing, lead tracking, quoting software; Optima II SMR, PCP, RCC, MSA, RSA, TAS billing software; Metrix intuitive dispatch scheduling software.

Circle (440) See classified ads

Midian Electronics Booths 929, 931, 933

Existing products—UED 1 universal encoder and decoders; ANI 1 universal automatic number identification; TVS 2 rolling code voice scramblers.

New products—RT8M Maxon SP2000 compatible trunked radio-telephone radio; TDS 1 tone digital squelch board; RD 10 and RC 10 remote control products.

Circle (441) See ad page 48F

Midland Land Mobile Radio Booth 326

Existing products—Syn-Tech XTR mobiles, portables and desktop stations; Syn-Tech II half duplex mobiles, duplex mobiles and stations; Base tech dispatch and repeater stations; voice storage; high security scrambling; mobile in-band and dualband repeaters; signaling.

New products—Channel sharing systems (CSS) and CSS model 70-9020 trunking radios with LTR compatibility.

Circle (442) See ad page 32

Mobile Mark Booths 265, 267

Existing products—Vehicular antennas for cellular, trunking, land mobile and amateur frequencies; installed and portable antennas including RM series roof antennas with Quick Disconnect, glass-mounted dualband antennas, cordless clip-on antennas with adjustable pick-up rod, low-profile mag mounts.

New products—Clip-on coupler antenna series available for MicroTAC, MicroTAC Lite, OKI-900 and Murata.

Circle (443) See ad page 46

GO AHEAD, CALL US NARROW MINDED...

AT 220 MHZ.

For over a decade, SEA has built the most durable, state-of-the-art narrowband radio products. And we don't mind saying that's all we do.

So it should come as no surprise that the first transceivers and base stations type-accepted for use at 220 MHz are designed

and manufactured in the USA by SEA.

While other companies scramble to jump on the narrowband bandwagon, SEA equipment is available now! And no other company will ever have more experience in the field.

For more information, call 1-206-771-2182.



THE LEADER IN NARROWBAND TECHNOLOGY

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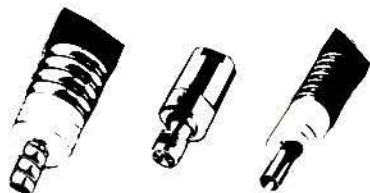
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CELLFLEX® Closed cell foam dielectric with low density & high velocity

AVAILABLE IN
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LLFLEX® Foam - stranded inner conductor, excellent flexibility, low loss
AVAILABLE IN 1/2"

SANTA FE CAN CUT TO LENGTH & INSTALL CONNECTORS REELS or BOXES

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CELWAVE RFS
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913-492-8288 Local

913-894-2136 Fax

WE CAN FILL YOUR NEEDS WHETHER LARGE OR SMALL

Circle (68) on Fast Fact Card

Mobile Radio Technology Booths 451, 453

Existing products

Written to keep industry professionals up to date on the latest in equipment, technology, techniques, business developments, legal and regulatory matters, **MRT** is recognized as the leading source of technology-oriented industry guidance. Visit our booth to pick up a copy and to sign up for your free magazine subscription.

Circle (444)

Modular Communication Systems Booths 360, 362

Existing products

Ultra-Com Pro workstation; Ultra-Com 96 DT desktop console; user-programmable systems; touch-screen monitors.

Circle (445)

See ad page 65

Motorola Test Equipment Booth not assigned

Existing products

R-2600 communications systems analyzer.

Circle (446)

Multiplier Industries Booth 944

Existing products

Batteries and battery eliminators for two-way radios; batteries for pagers and custom packs for laptop computers and other equipment.

Circle (447)

See ad page 20

MX-Com Booth 606

Existing products

Pvt Squelch privacy modules for two-way radio; Cypher-MX VSB variable split band scramblers for two-way radio; Radio MailVox voice storage and retrieval modules for two-way radio; computer aided dispatch (CADi) modules to add on to PC or radio.

New products

MX P10 CADi computer aided dispatch computer card; N-Tone encoder and decoder; MX P25 CADi computer aided dispatch Selcall N-Tone encoder and decoder module.

Circle (448)

See ad page 7

Nady Systems Booth not assigned

Existing products

VHF-30 5W transceiver; VHF-40 5W transceiver; UHF-50 5W transceiver; EasyTalk radio communicators.

Circle (449)

Newmar Booth 1537

Existing products

Varicom 20; heavy-duty power supply; basecom power supply; stainless-steel battery charger.

New products

115-12-100RM battery eliminator and charger; 360-2007-0 power pac; a power supply with built-in battery; 24-12-3ISP dc converter, isolated with spike/surge suppression.

Circle (450)

See ad page 24

NorComm Booths 1048, 1050

Existing products

Data signaling encoders and decoders for CTCSS; two-tone sequential; DTMF; digital coded squelch; single tone burst; 1,500Hz and 2,805Hz digital.

New products

NC401 DTMF decoder; NC409 DTMF ANI

encoder.

Circle (451)

See ad page 81

Orbacom Systems Booth not assigned

Existing products

TDM-150 digital command and control.

New products

Calida Plus.

Circle (452)

See ad page 21

Pace Booth 1175

Existing products

Benchtop systems for assembly, rework and repair of electronics; SMT component installation and removal; soldering and desoldering stations; circuit board repair and modification; fume extraction systems; training services.

New products

MicroChine miniature machining system for safe repair and modification of advanced electronics; Process Monitor for analysis of thermal performance and EOS/ESD safety parameters of soldering and desoldering stations; Pik & Paste automatic liquid dispensing and component handling system that does not require shop air.

Circle (453)

PacketCluster Systems Booth 1332

Existing products

Mobile data communications; wireless messaging.

New products

PacketCluster mobile data communications for public safety.

Circle (454)

Page-Com Booths 1546, 1548

Existing products

Radius series portables.

New products

Radius GM300 repeater; Radius GM300 mobile.

Circle (455)

PageTek Booth not assigned

Existing products

ProTek-24 monitor, alert and control system; ProTek jr. monitor, alert and control system.

New Products

ProTekTor tower light, site monitor alert and control system.

Circle (456)

PanaVise Products Booths 1352, 1354

Existing products

Standard phone mounts; deluxe phone mounts; slimline phone mounts; PortaGrip; universal radio mounts; mobile data terminal mounting system.

New products

Flex-mount.

Circle (457)

Parkinson Electronics Booth 102

Existing products

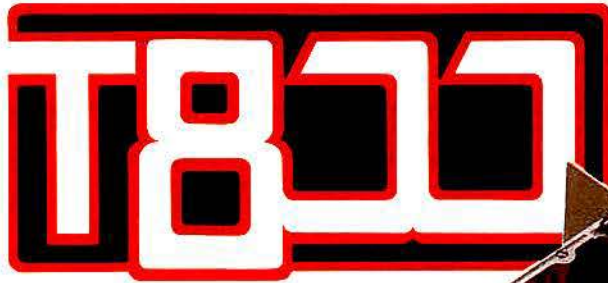
RP3, RP11 repeater kits to convert mobiles to repeaters; RV8-A, RV8-T dc and tone remote-term, panel, multi-channel, voice synthesizer; EL5 extended local remote for TMX8510, 8712 radios; PT2 power-down timer for battery-saving mobile radio applications.

New products

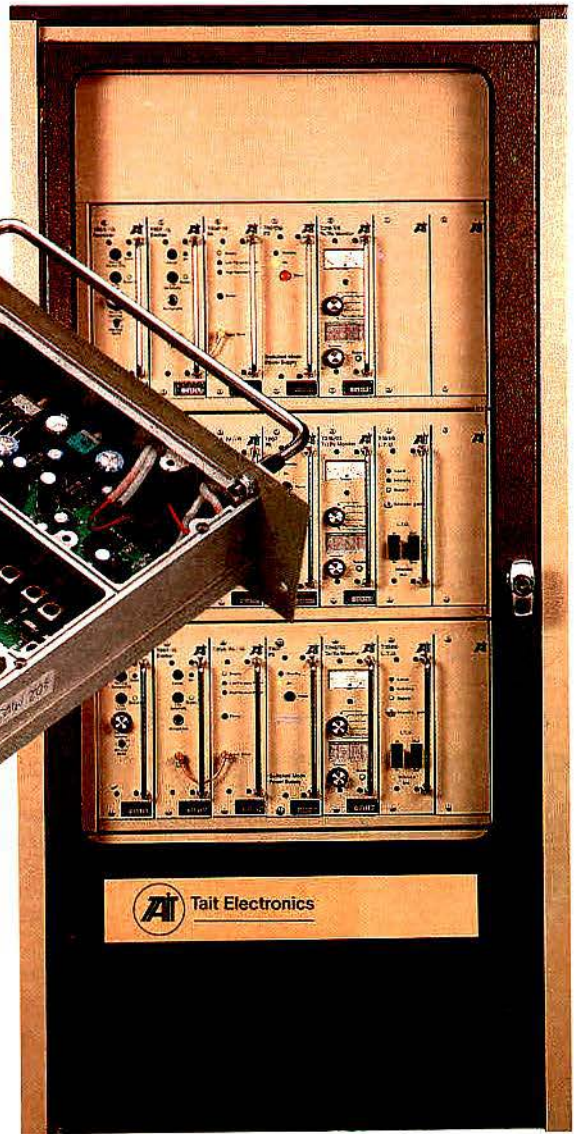
VEP-24 expanded version, 24 phone line, VEP-

The Heart of a Top Performer

THE TAIT



BASE STATION



Every two-way radio user is seeking better system performance, and better performance is why more and more systems operators are turning to the TAIT T800 SERIES OF BASE STATIONS and REPEATERS.

The system delivers better performance through:

- ☐ Higher specifications
- ☐ Innovative design
- ☐ Greater flexibility
- ☐ Total reliability

The TAIT T800 has been proven in some of the harshest, most demanding conditions on earth.

Talk to your nearest Tait office today about the T800 Series. Custom configurations can be designed to meet individual user requirements, including MPT 1327 TRUNKING SYSTEMS.

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Toll Free: (008) 07-7112
Fax: (07) 266-7559

HONG KONG

Tait Electronics Ltd
Phone: (852) 517-0000
Fax: (852) 517-1818

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Tait Electronics (Far East) Pty Ltd
Phone: (65) 253-5777
Fax: (65) 251-7778

USA

Tait Electronics (USA) Inc.
Phone: (713) 984-8684
Toll Free: 800 222-1255
Fax: (713) 468-6944

UNITED KINGDOM

Tait Mobile Radio Ltd
Phone: (0480) 52255
Fax: (0480) 411996



"Large enough to rely on and small enough to listen."

Expo

repackaged interconnect; SMA 92 tower lights monitoring alarm through radio circuits; RV8-K telephone key system remote control to multi-channel radio control stations.
Circle (458)

Polyphaser **Booth 1340**

Existing products—
Grounding and lightning arrestor products for coax (dc-6GHz), Data/Telco, ac and dc power.
New products—
3PB bulkhead entrance panel; models IS-PLDO-120-20A and IS-PLDO-220-SP ac plug-in protectors; grounding products 1C-1125, 6" x 1" gauge x 1.5" CU strap; 20C-1125, 20-40 to CU strap; MSC-3 universal 1.5" CU strap clamp.
Circle (459) **See ad page 76**

Positron Industries **Booth 853**
Existing products—
TRCC radio and telephone dispatch console.
New products—
PC keyboard-based TDD device for dispatchers.
Circle (460)

Quantum Publishing **Booth not assigned**
Existing products—
Cellular radio handbook; paging technology handbook; video tapes; audio tapes; software; reports; wide variety of information resources for the wireless industry.
New products—

"Cellular Marketing" by Robert Steuernagel; digital cellular telephony video tape series.
Circle (461)

Racom Products **Booth 569**

Existing products—
Life-Tel C.T.S. cellular telemetry system for ambulances; Life-Tel T.R.S. telemetry receiving system; 1601 solid-state announcer.
New products—
1402 programmable station identifier; 700 low-cost station identifier; Life-Tel T.S.S. telemetry sending system for UHF; radio medical telemetry.
Circle (462)

RadioMate **Booths 360, 362**

Existing products—
Headsets for portables, mobiles and base stations.
New products—
"Low profile" carset.
Circle (463)

Radio Systems **Booth 749**

Existing products—
Submersible rugged portable radios in crystal and synthesized versions, covering 30MHz to 512MHz; transportable weatherproof repeaters; telemetry modules; special forces wideband squad radio with automatic antenna coupler built in.
New products—

Custom SC-460 series encryption module for shock and vibration resistant mounting inside any Radio Systems submersible portable radio.
Circle (464)

Ramsey Electronics **Booth not assigned**

Existing products—
Com-3 communications service monitor; Sinad Plus automatic sinad meter; Com-6 universal code synthesizer.
Circle (465) **See classified ads**

Ranger Communications **Booth 1172**

Existing products—
UHF and VHF portable radios; mobile radios; base station and repeaters; digital paging transmitters; SMR trunking mobiles; rural telephone systems.
Circle (466)

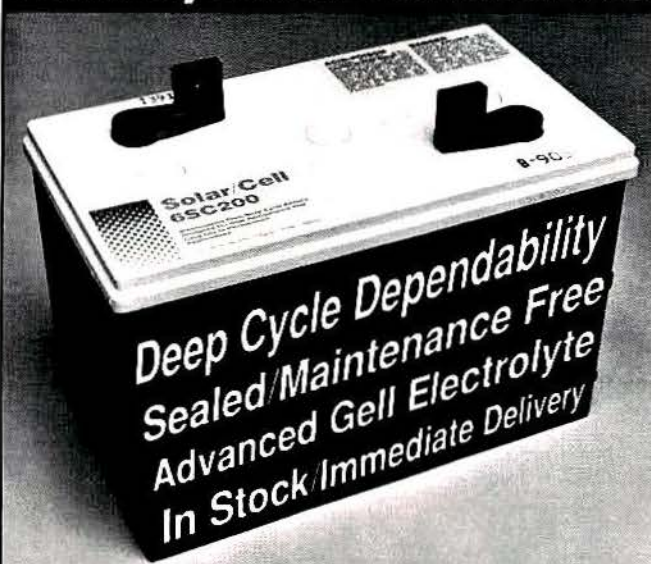
Reach Electronics **Booth 1625**

Existing products—
2VR152 highband and 2VR32 lowband tone and voice pagers; 2VR153 highband and 2VR33 lowband tone and voice pagers.
Circle (467)

Relm **Booths 725, 727, 729, 731**

Existing products—
RSP500B, RSP400 plus portable radios; RMU45NB, RMV60B, RML60 high power plus mobile radios; LMV2548 plus mobile radio;

Solar/Cell Batteries



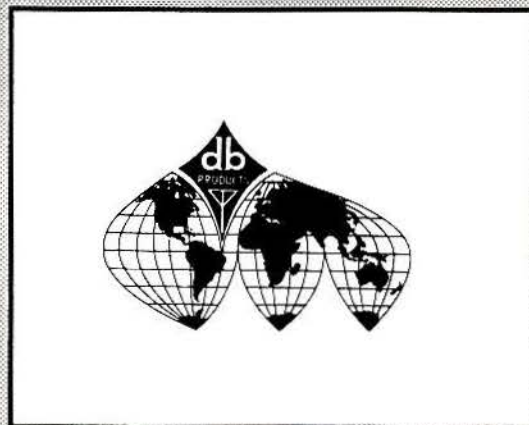
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Order Hotline 800-344-2003

Circle (70) on Fast Fact Card



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Decibel Products Quality
Primus Electronics Service**

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Circle (71) on Fast Fact Card



Synthesized, Field Programmable
11 channels
5 Watts VHF/UHF
8 Hr Battery Life,
10 Hr Battery Available
Frequency Bands: 136-174
400-430, 450-512 MHz
Wide Band Operation:
VHF 15MHz UHF 20 MHz
Scan
Tone Coded Squelch
Digital Coded Squelch
Two-Tone Sequential Decode
Rugged, Uni-Body Housing
Two Year Factory Warranty
Made In USA

VHF \$429 UHF \$449



Synthesized, Field Programmable
16 channels
30 Watts VHF 25 Watts UHF
Frequency Bands: 136-174
400-430, 450-512 MHz
Wide Band Operation:
VHF 15MHz UHF 20 MHz
Scan
Tone Coded Squelch
Digital Coded Squelch
Two-Tone Sequential Decode
Rugged, Uni-Body Housing
Two Year Factory Warranty
Made In USA

VHF \$469 UHF \$499



*Portable comes with: battery, antenna, wall charger and belt clip.
Optional accessories: DTMF keypad, speaker microphone, earphone
or headset, fast rate drop-in charger and carry holster*

*Mobile comes with: installation kit, hand microphone
and external speaker jack. Optional accessories: DTMF
hand microphone and 5 watt external speaker.*

DEAL WITH IT.

The new line of Patriot two-way radios really gives you something to deal with. Not only do you receive the benefits of a premium product line that's built in the USA by Ritron, but a product line with high dealer margins. And even more than that, you get strong dealer

support from the factory. It's true we have Patriot radio dealers worldwide, but right now a limited number of dealerships are still available. So take advantage of a truly patriotic deal, and call us at 1-800-USA-1-USA. **PATRIOT**
FAX: 317-846-4978. BY RITRON

Circle (72) on Fast Fact Card



Two Year Warranty applies to product sold in USA. Certain frequency bands special order

Get
MORE
from your
MOTOROLA
trunked radio system with
TRIDENT'S M-500
AIRTIME LOGGER

Busy Q wait time statistics
Two period airtime logging
550 hours airtime per ID code
Channel frequency assignment

Remotely programmable
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10221 Slater Ave., Suite # 103 Fountain Valley, CA 92708 (714) 549-5206

Visit us at IMCE, Booth #304/306/308.

Circle (73) on Fast Fact Card

THRULINE

Broadband RF Wattmeter— imitated but never improved.

THRULINE is the first and only name in wattmeters. The Model 4304A wattmeter is accurate, versatile and easy to use.

- Single element operation—no change necessary
- Measures forward and reflected power
- Measures 5-500 watts full scale on 5 power ranges
- 25-1000MHz operation
- Light weight, rugged construction

Call or write for more details on how THRULINE Model 4304A RF wattmeter can simplify your two-way RF equipment testing.



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Circle (74) on Fast Fact Card

Expo

RFH1252NB, RH256NB, TRH202 mobile radios; SLV40, SLU25 mini-com plus compact mobile radios; WH WU, WS series repeaters and base stations; DU, RDPL series duplexers; cavity filters; combiners.

New products

Mini-com plus PTV56 compact portable VHF radio; Utili-com UC2200 compact portable VHF utility radio.

Circle (468)

See ad page 59

RF Industries

Booths 635, 637

(Neulink and Connector divisions)

Existing products

RFA-4024 Unidapt kit; RFA-4040 Unicable kit; RFA 4059 Unidapt coaxial cable sampler; RFA-4045 Unidapt wattmeter.

New products

Neulink's DCL 2400 modem series; Neulink's extended wireless phone system.

Circle (469)

Riser-Bond Instruments

Booth 1476

Existing products

2901B+ TDR cable fault locator; 3000 TDR cable fault locator; 525 cable identifier.

New products

1220 TDR cable fault locator.

Circle (470)

Ritron

Booth 1132

Existing products

Synthesized, programmable VHF and UHF portable and mobile two-way radios; crystal controlled Jobcom two-way radios; repeaters and telephone interconnect systems; telephone line extender system for UHF, full duplex; telemetry and radiomodem systems.

New products

Model RPM-050 synthesized, programmable Patriot lowband mobile radio, 30MHz-50MHz, 16 channels, 60W; synthesized, programmable Patriot UHF portable radio, 460MHz-480MHz, 5W, 11 channels.

Circle (471)

See ad page 71

Rohn

Booth 1232

Existing products

Concrete equipment shelter; fiberglass equipment shelter; guyed towers; self-supporting towers; poles.

Circle (472)

See ad page 66

Sabre Communications

Booth 338

Existing products

Guyed and self supporting towers; prebuilt equipment shelters; HF antenna systems.

New products

Series 4400 solid round welded tower system.

Circle (473)

Sage Data Systems

Booth 1261

Existing products

C\$ERVICE service management system for invoicing, work tickets, inventory, service history, maintenance contract profitability, technician productivity, air-time billing, recurring billing.

Circle (474)

Scala Electronic

Booths 1346, 1348

Existing products

Fixed-station antennas for cellular, 800MHz and

WirelessWorld Conference & Exhibition

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BUSINESS

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Buena Vista Palace
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Fax This Page to 312/922-1408 Attn: Tina Rubin

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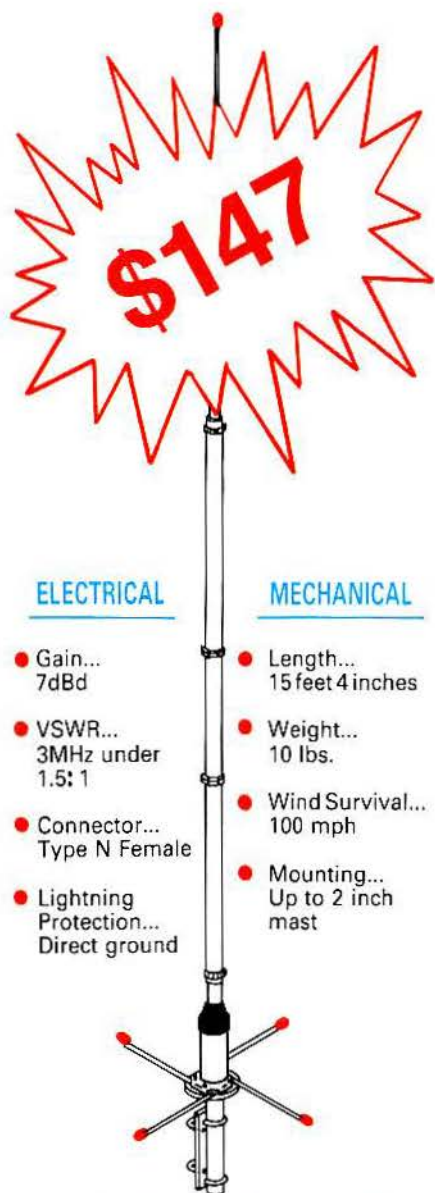
Or call Tina Rubin at 800/458-0479 or fax 312/922-1408

Cellular Business • 55 East Jackson Blvd. • Suite 1100 • Chicago, Illinois 60604

Circle (75) on Fast Fact Card



G7-150 Series 148-174 MHz Omnidirectional Fixed Station



ELECTRICAL

- Gain... 7dBd
- VSWR... 3MHz under 1.5:1
- Connector... Type N Female
- Lightning Protection... Direct ground

MECHANICAL

- Length... 15 feet 4 inches
- Weight... 10 lbs.
- Wind Survival... 100 mph
- Mounting... Up to 2 inch mast

**CALL NOW
800-949-9490**

IN TEXAS CALL COLLECT (817) 325-1386

HUSTLER, INC.
One Newtronics Place
Mineral Wells, Texas 76067

Circle (76) on Fast Fact Card

Expo

900MHz trunking, point-to-point, two-way communications, telemetry, MAS, paging and ground-to-air communications.

New products

Americell sector antennas series.

Circle (475)

See ad page 31

Schlumberger Technologies

Booths 1547, 1549

Existing products

4031 portable communications test set; 4040 precision radio test set; 6910 precision test receiver; 4922 radio code analyzer; 4015 communications monitor.

New products

4031D Stabilock and North American digital cellular tester; 9200 GSM tester; 4015 communications tester with EDACS trunking capabilities.

Circle (476)

See ad page 15

Scientific Dimensions

Booths 1438, 1440

Existing products

Quick Connection slide mount; series 5000 pedestal mount; Goosnek series flexible steel pedestal mount.

New products

Mobile office mounting kits—SDI 8000, SDI 8003, SDI 8007 and SDI 8020; air bag sensitive mounting equipment for public safety applications, SDI 7623, SDI 7001.

Circle (477)

See classified ads

SEA

Booth 448

Existing products

220MHz narrowband trunked conventional radio systems; ESP1000 220MHz narrowband repeaters; ESP504 220MHz narrowband mobile radios; ESP520 220MHz narrowband mobile radios.

Circle (478)

See ad page 67

Selectone

Booths 1147, 1149, 1151, 1153

Existing products

Tone signaling—CTCSS, DCS, two-tone, burst, DTMF; ANI; voice encryption.

New products

ST-1000 mobile data messaging system.

Circle (479)

See ad page 3

Setcom

Booth not assigned

Existing products

Headset, helmet com-kits and SCBA com-kits for portable and mobile radios; vehicular intercom/radio mixer system.

New products

System 1300 airport rescue/fire fighter vehicular intercom/radio mixer.

Circle (480)

See ad page 56

Sharp Communications

Booth 1470

Existing products

Mobile communications equipment; site management equipment; strobes and safety signals; mobile messenger voice message and information system; on-hold message programs.

New products

AutoLoader 500 digital voice announcement system for telephone on-hold messaging.

Circle (481)

See classified ads

Shinwa Communications of America

Booth 748

Existing products

CM3 pagers; pen pagers.

New products

STAT series; mobiles; portables.

Circle (482)

Shure Brothers

Booth 751

Existing products

ModuLink 590T, 885TT and 890TT.

Circle (483)

Sigtone

Booths 243, 245

Existing products

PI356 status reporter; Mobi-Script base dispatch software; Mobi-Stat base dispatch software; A1202 ANI unit; A1458/20 ANI display decoder and unit; S1515 selcall unit.

New products

M2400 series mics; T2160 remote control and monitoring unit T8053 mobile data terminal; S1530 MVS signaling module; A 1204 ANI module; T2001 Mobi-Cab bid box.

Circle (484)

Sinclair Radio Laboratories

Booth 560

Existing products

Base station antennas; cellular antennas; duplexers; filters; transmitter combiners; receiver multicouplers; isolators; mobile duplexers.

New products

SRL 411, SRL 490, SRL 475 cellular autotune combiner.

Circle (485)

Skaggs Telecommunications Services

Booth 1520

Existing products

Modular Concept Custom Designs electronic furniture consoles; STS special purpose mobile security vans and command centers.

Circle (486)

Slattery Software

Booth 1505

Existing products

Quickform 574; Minute Quotes software for FCC licensing and proposal generation.

New products

Quickform series 401, 402, 489, 494, and Sched-B for printing FCC forms on laser printers.

Circle (487)

SMC Electro-Mount

Booths 1445, 1447

Existing products

Unilok series mounts; UCC series communications consoles; electro-mount series pedestal and flex mounts.

New products

Sprint 7000 controller; S2000 series stack mounts.

Circle (488)

SoftWright

Booth 470

Existing products

Terrain analysis package (TAP), PC-based software to perform evaluation of existing or proposed transmitter sites; radio coverage predictions, microwave, paging, cellular and two-way radio system design.

New products

Antenna patterns distortion module version 2.3f, Alaskan topographic data on CD-ROM.

Circle (489)

See classified ads

Special Industrial Radio Service Association (SIRSA)

See Industrial Telecommunications Association (ITA) for listing.

Spectrum Communication Booths 447, 449

Existing products—Paging transmitters for VHF, UHF and 900MHz; high-power amplifiers and power supplies; link transmitter and receiver systems; repeaters; boards; filters.
Circle (490) See ad page 82

Standard Communications Booth 640

Existing products—HX240 series portables; HX340 series portables; HX440 series portables; HX580 series trunking portables; GX1500 series mobiles; GX2000 series mobiles; GX3030 series trunking mobiles; RP70 series repeaters.
New products—LMR 5 & 6 community repeaters; GX5810 mobile trunking radio; 800MHz trunking repeater and controller.
Circle (491) See ad page 41

Sti-Co Industries Booths 233, 235

Existing products—Disguised mobile two-way antennas including custom fender-mount lowband, highband, UHF and broadband models; cellular look-alike VHF and UHF antennas; low profile transit antennas in highband, UHF, 800MHz and 900MHz; special use antennas; couplers; tuners; and dual matched systems.
New products—Model ROF-BL-150/450 disguised dualband cellular look-alike in VHF and UHF; model S-450 disguised custom fender-mount UHF broadband antennas covering 20MHz within the 405MHz-512MHz frequency range; custom fender-mount disguised antennas for 1993 models: Plymouth Concorde, Dodge Intrepid, Jeep/Eagle Vision, Eagle Talon, Jeep/Eagle Grand Cherokee, Chevy Camaro, Pontiac Firebird, Ford Probe and Mercury Villager—available in lowband, highband, UHF and broadband.
Circle (492)

Tad Radio of Canada Booths 566, 570

Existing products—Wideband VHF and UHF mobile radiotelephones.
New products—M8 synthesized mobile radio with LCD and custom software.
Circle (493)

Tait Electronics Booth 404

Existing products—T800 base station radios.
New products—T2000 mobile radio product line.
Circle (494) See ad pages 52, 69

Tekk Booths 1074, 1076

Existing products—Handheld radios; data radios; modems; O.E.M. services.
New products—T-20 low-cost slimline handheld; T-50 low-cost

slimline handheld; T-Mode radio modem.
Circle (495)

Telex Communications Booth 1466

Existing products—Communications headphones and headsets.
New products—EM300 Earmike transducer worn in the ear combining microphone and earphone receiver; Magnacom emergency vehicle intercom.
Circle (496) See ad page 28

Tessco Booth 254

Existing products—Site management equipment, antennas, cable, connectors; cellular and two-way accessories; mobile and portable antennas; bench equipment, tools and shop supplies; test equipment and computers.
New products—Buyers' Guide with pricing effective March 1 details more than 10,000 products from manufacturers.
Circle (497)

TPL Communications Booth not assigned

Existing products—Mobile, base station and repeater amplifiers covering frequency ranges from 35MHz to 970MHz; power ranges from 10W to 500W.
New products—Mobile charger for the Relm portable RSP500 radio; mobile amplifier charger for the Standard HX440 series portable radio.
Circle (498)

Transcrypt International Booth 760

Existing products—Crypto Voice Plus (CVP) scrambler line; CS encrypt scrambler line; cellular and landline phone scramblers and systems; signaling and status modules; T-CAD computer aided dispatch; fleet management controller.
New products—SC 20-406 exportable version of CVP scrambler; SC 20-480 system ready scrambler with less than one second late entry capability.
Circle (499) See ad page 5

Trident Micro Systems Booths 304, 306, 308

Existing products—TNT series logic and interconnect controllers; CR-355 interconnect call router; VM-400 voice mail system; M-500 airtime logger for Motorola systems.
New products—TNT-110 and TNT-120 logic and interconnect controllers.
Circle (504) See ad page 72

TWR Lighting Booth 343

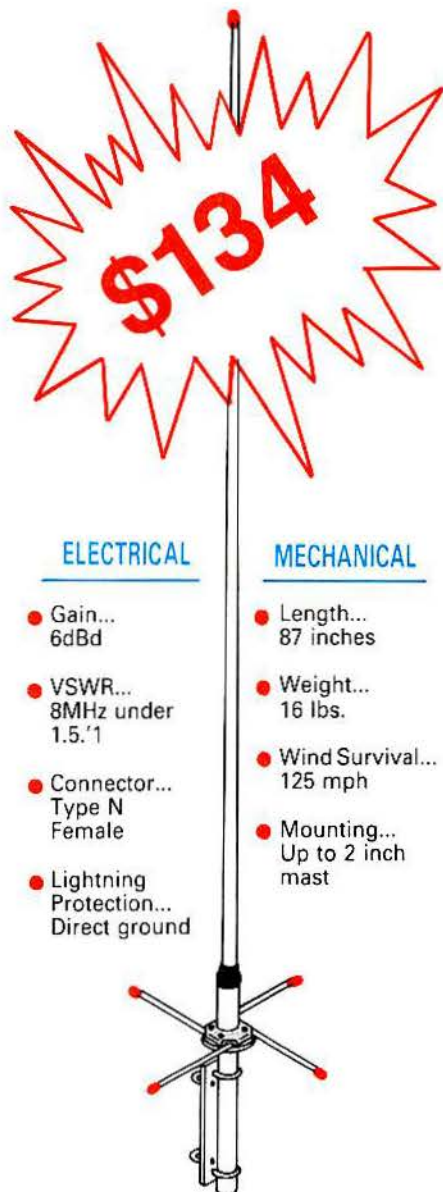
Existing products—FAA-approved aviation lighting; medium intensity strobes; 300mm code beacons; obstruction lights; controller alarmed and non-alarmed solid state and motor driven; junction boxes; complete light kits.
Circle (505) See classified ads

Tx Rx Systems Booth 1022

Existing products—Duplexers; resonant cavity filters; multicouplers;



G6-450 Series 450-470 MHz Omnidirectional Fixed Station



ELECTRICAL

- Gain... 6dBd
- VSWR... 8MHz under 1.5:1
- Connector... Type N Female
- Lightning Protection... Direct ground

MECHANICAL

- Length... 87 inches
- Weight... 16 lbs.
- Wind Survival... 125 mph
- Mounting... Up to 2 inch mast

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Circle (77) on Fast Fact Card

NEW Isolating Protector Stops Lightning on Coax Line

100%

STRIKE
ENERGY

New IE Series Protector COAX

50% SHIELD

50% CENTER

99.9% TO GROUND

Typical DC Center Blocked

100%

STRIKE
ENERGY

COAX

50% SHIELD

50% CENTER

≈25%
TO
RADIO

≈75% TO GROUND

Our patented Isolated Equipment (IE) Series Protectors ground and then *isolate* both the *shield* and the *center* conductor of your coax line. Lightning is diverted to the outside ground system. It can not travel to the equipment chassis and follow the electrical wires to ground which can happen with all other type protectors including 1/4 wave shorted stubs. The IE Series Protectors are available from 1.5MHz to 2.6GHz (to 20GHz Special). This innovative and unique series is **99.9% effective**, setting a whole new meaning to the term "Coax Protector". Of course it's from the World Leader in RF coax protection.

**1500 models of coax, power and twisted
pair protectors . . . plus lightning/EMP
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Circle (78) on Fast Fact Card

Expo

signal booster systems; RF system products and associated hardware.
Circle (506)

Uniden America

Booth 525

Existing products

VHF, UHF, 800MHz and 900MHz mobiles, portables, repeaters and base stations in conventional and trunking; accessories.

New products

ESAS trunked networking system; 220MHz mobiles and repeater systems; SPS330TSD full duplex, 800MHz trunking portable; IMH4100/IMU3100 wideband mobile radios in VHF and UHF.

Circle (507)

See ad page 63

Valmont Industries

Booths 261, 263

Existing products

24"-face guyed tower, pre-welded sections; monopoles in taper, tubular, steel, self-supporting communication structures.

New products

Various mounting arrangements for mounting of antennas to communication structures customized to customer needs and specifications.

Circle (508)

Valor Enterprises

Booth not assigned

Existing products

Land mobile antennas and accessories; base station; yagis; cellular antennas and accessories; micro magnetics and accessories.

New products

Micro magnetic quarterwave and 3dB gain val-clip antenna systems; clip-on antenna systems for handheld phones or radios.

Circle (509)

VCP International

Booths 1442, 1444

Existing products

Numeric display pagers; UPS systems; cellular and SMR antennas; cellular phones; alphanumeric pagers; tone and voice pagers.

New products

Panasonic cellular phones.

Circle (510)

See ad pages 36, 83

Vega

Booths 1028, 1030

Existing products

C-5112 10-line, 4-frequency radio control console; C-1614 6-line 4-frequency tone-remote desk console; C-583 8-frequency tone-remote desk console; 1223C tone-remote station adapter for type 10/400 type mounting shelves.

New products

C-5111 10-line, 4-frequency console with instant PTT switches and individual volume controls for unselected lines; cross-patch and phone-patch option for C-5112 console.

Circle (511)

See ad page 1

Vertex/Yaesu

Booth 312

Existing products

Two-way radio products, including the Vertex series mobiles and the dualband (VHF and UHF) handheld.

Circle (512)

See ad on IBC

W & W Associates

Booths 249, 251

Existing products

Replacement battery packs for two-way radios.

cellular and cordless phones, laptops, camcorders; pocket pager batteries and chargers.

New products

Chargers for two-way radios.

Circle (513)

See ad pages 37, 48A

Wacom Products Booths 1150, 1152, 1154

Existing products

Coaxial cavity filters; duplexers; transmitter combiners and receiver multicoupler systems operating in the 30MHz-960MHz band; isolators and load terminations.

Circle (514)

Wavetek Booths 337, 339

Communications Division

Existing products

Model 260 service monitor with 300 encoder.

New products

Model 3500A cellular test system; NAMPS test option; model 500 cellular identifier.

Circle (515)

Western Multiplex Booth 701

Existing products

Microwave Lynx T1 digital microwave radio with spread spectrum.

Circle (516)

Western Towers Booth 309

Existing products

Communications tower structures for monopole, self-supporting and guyed towers.

New products

MFN-L100 lightweight self-supporting tower.

Circle (347)

Willmar Technical College Booth not assigned

Existing services

Information about hiring graduates or enrolling in the college.

Circle (348)

See classified ads

Zetron Booth 950

Existing products

Interconnects; digital hybrids; repeater controllers; trunking remotes; trunking repeater controllers; radio networking and dispatch switches; mobile and dispatch control stations; paging encoders; paging terminals; paging accessories; radio remote/phone alarm and control systems; message recorders; fire station alerting system; radio console systems; ZM DTMF microphones; software billing, download and alpha paging programs.

New products

Model 15P field programmable desktop encoder; model 18/18+ control link; model 1801 multi-purpose status and control panel; model 42 dispatch trunking logic; model 63 dialink transmitter link module; model 55B page buffer; model 813 digital telephone repeater interface (TRIB); model 3010 printing ALI display; model 3022 instant recall recorder; model 7502 mobile encoder/decoder/transponder; model ZR-310 community repeater panel; model ZR-320 selective calling interconnect; model ZR-330 radiotelephone interface; AlphaZ paging program; autopath networking; rural radiotelephone system.

Circle (349)

See ad pages 57, 88



FIX IN-BUILDING RF problems with KAVAL COVERAGE EXTENSION SYSTEMS 800/UHF/VHF

- ▶ On frequency repeaters 5W, 127dB gain each channel
- ▶ Booster and line amplifiers
- ▶ Tapped RF distribution
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Systems design and integration

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Circle (79) on Fast Fact Card

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RADIUS
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YAESU

Circle (80) on Fast Fact Card

(continued from page 46)

signal by combining the outputs of multiple receivers (usually two) whose antennas are spaced by more than a quarter wavelength. Polarization diversity uses a similar setup with two antennas of different polarization. The technique works because signals received by separated antennas are unlikely to suffer

simultaneous fading.⁴

A voting system can be used to select automatically the best output signal from two or more receivers fed from diversity antenna systems. Typically, average received signal strengths are approximately 4dB better for two-receiver diversity combining and as much as 8dB better when four receivers are combined, as compared to a single receiver.

The greatest improvement is in the reduction in deep, sharp fades that may reach 10dB or more, even when two receivers are combined with either space or polarization diversity.⁵

► **Improved coverage**—Where well-defined areas must be covered, such as on a highway running north and south from the radio base station site, using two receivers connected to individual yagi antennas pointed north and south, for example, provides well-defined, high-gain coverage. This method uses standard antennas, as compared to the alternative of purchasing a specially designed, phased-antenna system.

► **Duplicated systems**—By combining two receivers through a SINAD voter, system redundancy for improved reliability can be provided. Redundancy may be especially useful at remote sites and sites with difficult access.

SINAD voting systems provide a powerful tool for planning systems that require wide-area coverage on common channels. SINAD voters can provide a means for co-located receivers to be added into a communications network, particularly where polarization-, space- or directional-diversity reception systems are being considered.

Care is required when implementing such systems, but experience has shown that SINAD voting systems cover large areas with ease. User satisfaction is especially high when operators no longer have to select zones and channels.

References

1. Holbeche, R.J. (editor), *Land Mobile Radio Systems*, Chapter 7. IEE Telecommunications Series 14, Peter Peregrinus Ltd., 1985.
2. "Quasi-Synchronous Operation of Two or more Transmitters," Pye Telecommunications Ltd., Engineering Notes, Pub. Ref. No. TSP361/2, April 1980.
3. Gray, G.D., "The Simulcasting Technique: An Approach to Total-area Coverage," *IEEE Transactions On Vehicular Technology* VT-28, May 1979.
4. Parsons, J.D. and M. Henze, "An Evaluation of Certain Diversity Reception Techniques for Mobile Radio," *IERE Conference Proceedings No. 33*, 1975.
5. Lee, W.C.Y., *Mobile Communications Engineering*, Chapter 10, McGraw-Hill, 1982.

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InterCom'93 and '94
March
Telecommunications, Computing, Energy

TelNets'93 and TelNets'94
July
Telecommunications, Networks

CenCom'93
August
Telecommunications, Computing, Energy

MexCom'93 and '94
January
Telecommunications, Energy

CosCom'94
August
Telecommunications, Computing, Energy

CANTO'93 and '94
June
Telecommunications

CaribeCom'92 and '93, and '94
October
Telecommunications, Computing, Energy

TrinCom'93 and '94
January
Telecommunications, Computing

VenCom'93 and '94
February
Telecommunications, Computing

ColCom'93 and '94
August
Telecommunications, Computing

TELEMATICA'93 and '94
May
Telecommunications

ChileCom'92 and '93 and '94
November
Telecommunications, Energy

LatCom'93 and '94
November
Telecommunications, Energy

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Circle (81) on Fast Fact Card

Technically speaking

(continued from page 8)

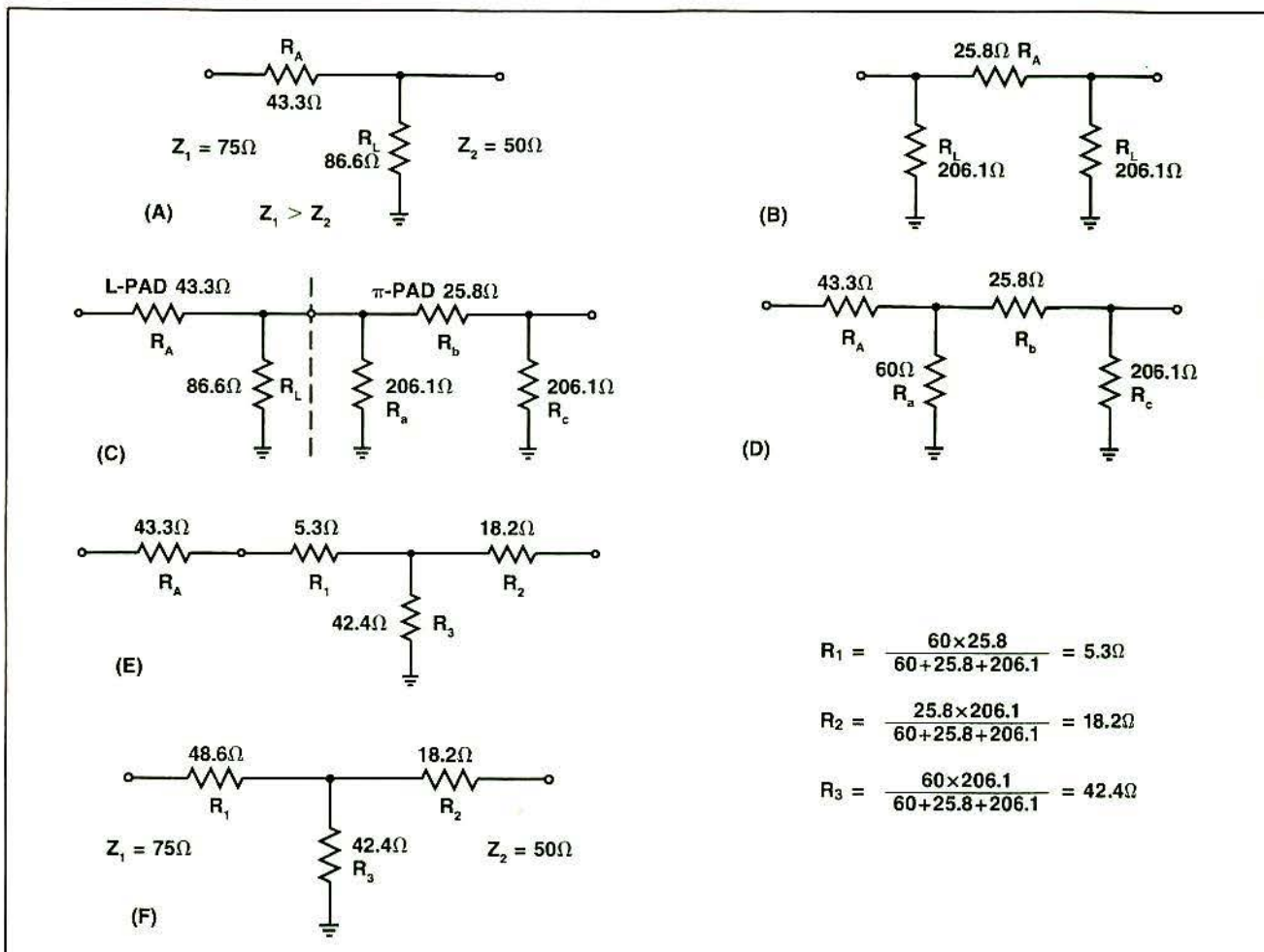


Figure 2. The process of evolution from 2A to 2F can be handled on a simple calculator to design a hybrid pad with 10dB loss.

Express yourself

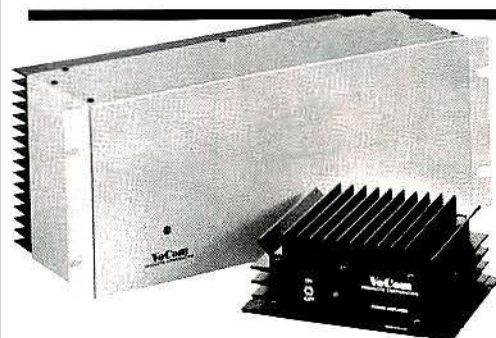
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Technically speaking

design the resultant T-pad at Figure 2F, they are complex and cumbersome to handle. The process of evolution shown in Figure 2 is easier to handle on a simple calculator and actually may be faster.

Construction

In building a simple attenuator or matching pad, it is important to use precision resistors.

Resistors with 1% tolerance should produce an attenuator with sufficient accuracy. Metal film resistors are preferred over composition resistors to provide better operation at high frequencies.

A power rating of $\frac{1}{8}W$ to $\frac{1}{4}W$ should be sufficient, unless you accidentally key the transmitter into the pad. Keep lead lengths quite short, especially if you are building a pad to use with RF.

Use a good-quality, shielded construction box, such as the cast aluminum type. The box should be as small as possible.

With asymmetrical pads, be sure to mark or otherwise identify each port's

impedance.

When using the various pad formulas, you inevitably will come up with some odd resistance values. You may have to use various combinations of resistors in series-parallel to achieve the desired resistance value. Use your imagination.

Testing the pad

The first step in pad testing is to terminate one port with the proper resistance and then measure the resistance at the other port.

Then repeat the procedure at the other port.

The old, familiar L-pad from Figure 2A appears again in Figure 3B. Here it is being tested with a dc voltage for the proper loss at dc.

This particular pad should show a 5.7dB loss. This does not mean that the voltage measured at one port is going to be 5.7dB below the voltage at the other port. The voltage at the 50Ω port will be 0.423 times the voltage applied to the 75Ω port.

Using the decibel formula:

$$dB = 20\log(E_0/E_1), \text{ we have:}$$

$$dB = 20\log(0.423) = -7.47dB.$$

Nonetheless, because the impedances at the two ports are different, it is necessary to apply a correction factor.

The correction factor is:

$$dB \text{ (correction)}$$

$$= 10\log(50/75)$$

$$= -1.76dB$$

Subtract this correction figure from the previous calculation of -7.47 to get:

$$-7.47 - (-1.76)$$

$$= -7.47 + 1.76$$

$$= -5.71dB$$

This is the actual attenuation of the



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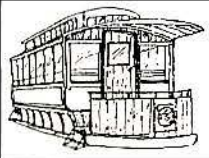
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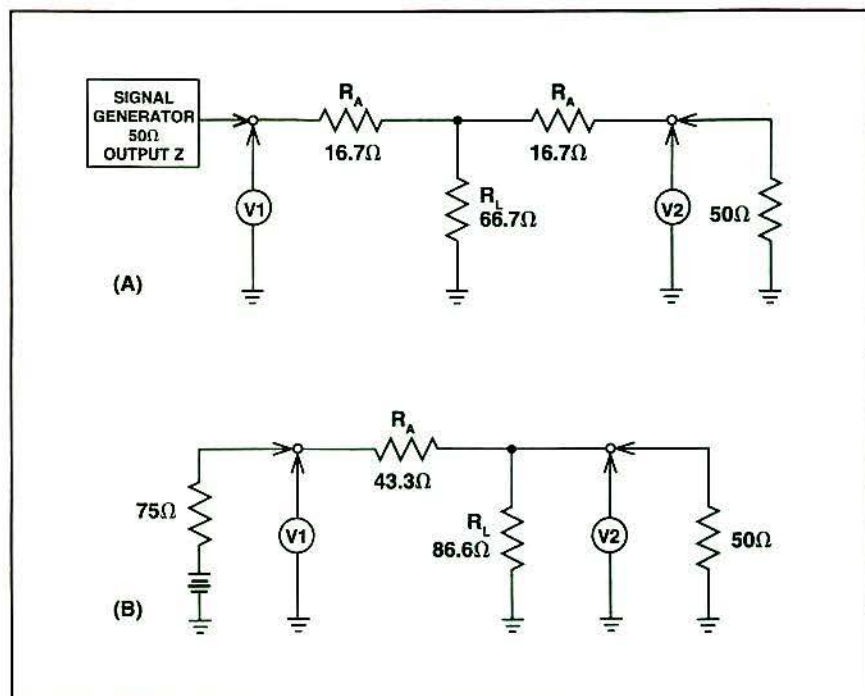


Figure 3. If you are testing a pad for use at RF frequencies, set up the test as shown in 3A. The old, familiar L-pad from Figure 2A appears again in 3B. Here it is being tested with a dc voltage for the proper loss at dc.

L-pad of Figure 3B. The pad's attenuation is bidirectional.

► **Dc loss test**—To perform the dc loss test as illustrated in Figure 3B, you must know the *ratio* of voltage output to voltage input.

For equal input/output impedances, the ratio is found as follows:

$$V_r = \text{antilog}(-\text{dB}/20)$$

For a 6dB pad with equal impedances, the calculation is:

$$\begin{aligned} V_r &= \text{antilog}(-6/20) \\ &= 0.501. \end{aligned}$$

For the L-pad at Figure 3B, the decibel loss figure is the sum of the pad loss (−5.7) plus the correction factor (−1.76), which equals −7.46dB.

Substituting yields:

$$\begin{aligned} V_r &= \text{antilog}(-7.46/20) \\ &= 0.4236 \end{aligned}$$

In performing the dc voltage test on a pad, be sure that the voltage level you use does not exceed the power-handling capability of the resistors used to construct the pad. Usually a 1.5V battery is a good choice.

As shown in the illustration, a resistance equal to the port impedance is connected in series with the voltage supply. The actual voltage applied across the input port is one-half of the supply voltage.

If the pad passes the ohmmeter and dc voltage checks, it probably is going to be fine to use at least at audio frequencies. If you are testing a pad for use at RF frequencies, set up the test as shown in Figure 3A.

► **RF loss test**—Connect an RF signal generator with a 50Ω output impedance to a 6dB T-pad with 50Ω input and output impedances. Connect a good-quality RF voltmeter first across the input port and record the RF voltage reading. Move the voltmeter to the output port and record the voltage reading.

Attenuation is determined by the formula:

$$\text{dB} = 20 \log(E_o/E_i)$$

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Technically speaking

No correction factor is needed because the voltage readings are taken at the same 50Ω impedance.

If you do not have a sufficiently accurate RF voltmeter, use an RF demod probe in conjunction with a dc voltmeter

according to the following method.


Measure the input port's RF voltage. Adjust the generator level to produce a known reference reading on the voltmeter. Record the reference reading and the signal generator output level.

Move the RF probe to the output port and increase the signal generator output level to produce the reference level on the voltmeter. Read the new signal generator level. It should be 6dB above the first generator level. If not, the pad is not suitable for use at this RF frequency.

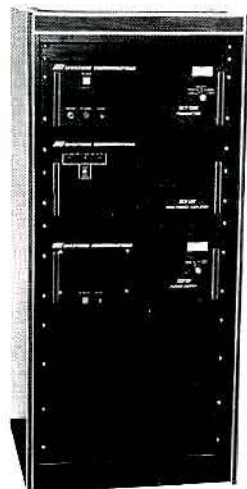
As the RF operating frequency increases, it becomes more difficult to build an attenuator pad that produces accurate results. Inductive and capacitive effects cause mismatches, and the VSWR increases.

Leakage past the attenuator becomes a problem, invalidating the attenuation rating. The problem can be avoided to some extent by making attenuators with less attenuation per unit and then connecting two or more together to achieve the desired attenuation level.

Leakage around the attenuator becomes more pronounced at higher attenuation levels. At UHF frequencies, such problems quickly become prohibitive. Commercially built, resistive attenuators rated for use to 1GHz and above incorporate special compensating inductors and capacitors along with special resistors to extend the frequency range.

A computer program that aids in the design of all these types of pads, including T-to- π and π -to-T transformations, is available for \$5, plus \$2 shipping and handling. Write the author at P.O. Box 15178, Spartanburg, SC 29302. 

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Uniden makes 220MHz equipment with open-architecture trunking

Uniden America, Fort Worth, TX, plans to offer system backbone equipment for the 220MHz private land mobile radio band, including repeaters, amplifiers, combiners and antennas.

In addition to hardware specifically designed for the band's 5kHz channels, Uniden has developed an advanced form of trunking logic called enhanced subaudible signaling for use with its 220MHz equipment. The logic will be made available in the company's 800MHz and 900MHz radios, too.

The new trunking logic is open architecture, and Uniden will make it available to

all land mobile product developers. In addition to seamless automatic roaming, the new logic provides individual unit ID numbers, voice mail, group calls and individual unit paging.

Prototypes are being field tested and are expected to be submitted to the FCC for type acceptance, according to information released on Jan. 15. Uniden expects to receive type acceptance for base station and mobile equipment in plenty of time for new licensees to use it in meeting FCC construction deadlines. The equipment will not be offered for sale until FCC type acceptance is granted.

AER-Aerotron asks court for protection from creditors

AER-Aerotron, a Raleigh, NC-based radio communications equipment manufacturer, petitioned the federal court on Jan. 11 for protection from creditors under Chapter 11 of the Bankruptcy Act.

Ernie Schwab, AER-Aerotron's president, has left the company. Andrew and Anthony Kostantinidis have assumed the management of the company. Andrew Kostantinidis is chairman of AER-Aerotron's parent company, Orlando, FL-based Atlas Financial Holdings, which purchased AER-Aerotron in 1990. Anthony Kostantinidis, Andrew's son, is president of Atlas.

According to Andrew Kostantinidis, "product quality and payment difficulties" precipitated the court petition.

AER-Aerotron's future is linked with that of Atlas and two other Orlando companies, Repco and Aerotron-Repeco Sales.

Atlas owns AER-Aerotron and Aerotron-Repeco Sales as private companies. Since 1987, Atlas has owned a majority interest in Repco, a public company.

Repco petitioned the court for protection from creditors under Chapter 11 of the Bankruptcy Act in December 1992. It sought relief from a lease for a manufacturing and headquarters building with several times the space required for its current business volume.

Atlas formed Aerotron-Repeco Sales in December 1991 to consolidate AER-Aerotron's and Repco's sales operations. Although Aerotron-Repeco Sales began re-selling Repco products in December 1991, only recently has it begun re-selling AER-Aerotron products.

Andrew Kostantinidis said that AER-Aerotron will take advantage of an opportunity for additional consolidation with the Orlando operations. Pending court approval, the company expects to relocate its engineering and manufacturing operations

to a smaller facility in Raleigh in June. The company's other operations will be consolidated with those of Atlas, Aerotron-Repeco Sales and Repco at 2400 Sand Lake Road, Orlando, FL 32809; 407-856-1953.

"Atlas purchased AER-Aerotron in 1990 with the understanding that it would be moved into Repco," Andrew Kostantinidis said. "Now we will see how we can make both companies survive."

AER-Aerotron manufactures FM radio communications base stations, repeaters and paging transmitters, as well as amplitude companded single-sideband (ACSSB) base station and mobile radios and FM mobile radios for railroads. "The company has more than 35% of the U.S. market for railroad clean-cab radios," Kostantinidis said.

AER-Aerotron is developing spread-spectrum radio communications equipment. Spread-spectrum railway equipment will be sold under the AER-Aerotron brand, and spread-spectrum data communications equipment will be sold under the Repco brand. "Both companies will have new products," Kostantinidis said.

ComDev specializes in building radio communications systems

Communications Development Systems (ComDev), Fairfield, NJ, specializes in two-way radio, paging and cellular communications construction. Partners in the newly formed company include Rich Berliner, Mark Malick and Robert Franco. ComDev has been appointed the Northeast representative for FWT, handling its product line of towers, cell sites on wheels and shelters. ComDev is located at 4 Gardener Road, Fairfield, NJ 07004; 201-227-8886.

Maxrad opens new headquarters

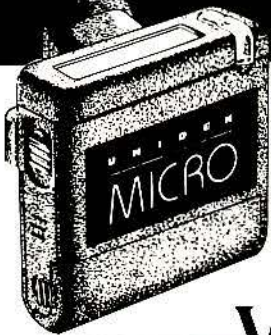
Maxrad has moved its home office and manufacturing plant to a new, 32,000 square foot facility in a Chicago suburb. Maxrad is located at 4350 Chandler Drive, Hanover Park, IL 60103; 800-323-9122; fax 708-372-8077.

Andersen Consulting oversees Phoenix PD CAD project

The Phoenix Police Department has awarded an \$8.6 million contract to Andersen Consulting for replacing its 12-year-old computer-aided dispatch system. Andersen Consulting, a system integrator, will oversee the project that includes Hewlett Packard, Motorola and Public Safety Systems Inc. (PSSI).

The mobile data terminal system has been designated a beta test site by Motorola and will include components of its Private Data TAC systems. The current system operates 650 vehicular MDTs that will be replaced by 680 model 9100-386 mobile workstations and 25 PDT-220 portable data terminals.

The system will be installed in a new communications center that is part of a new 123,000 square foot Property, Supply and Communications building. Final implementation is scheduled for Fall 1993.



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FCC creates Emergency Medical Radio Service

The FCC voted on Jan. 14 to establish a new radio service called the Emergency Medical Radio Service (EMRS).

EMRS joins the Fire Radio Service, the Police Radio Service, the Local Government Radio Service, the Highway Maintenance Radio Service and the Forestry-Conservation Radio Service as a member of the public safety family of private radio services.

The commission acted in response to a petition filed several years ago by the International Municipal Signal Association (IMSA) and the International Association of Fire Chiefs (IAFC). The FCC has designated IMSA and IAFC to coordinate EMRS frequency assignments, which will come from channels reallocated from the Special Emergency Radio Service (SERS) and five additional channels allocated to EMRS in the new 220MHz land mobile radio band.

EMRS frequencies are expected to be used by fire and rescue agencies of local government operations that have paramedics, emergency medical technicians, hazardous materials teams, volunteer fire departments and others that perform pre-hospital medical services. These radio users sought access to a protected block of frequencies to avoid competing for radio channel access with other users in the SERS.

On SERS channels, medical service providers had to contend with competition and sometimes interference, whether avoidable or not, from school bus radio communications, among other services.

In using EMRS frequencies that have public safety radio status, the medical service providers are expected to have quicker access to clear frequencies and less interference.

* * *

Fines

The FCC continues to fine radio licensees for tower painting and lighting rule violations over which the licensee may have no control.

Other license violations, such as modifying systems without prior FCC authorization, are coming under increased scrutiny.

Everyone would be well advised to review his license to check for accuracy and to discuss with tower owners the need for (and responsibility for) maintaining lighting and painting as specified on the license.



"Regulating Technology" is compiled from information provided by Alan S. Tilles, Esq., MRT's regulatory consultant, and by the International Municipal Signal Association, Newark, NY.

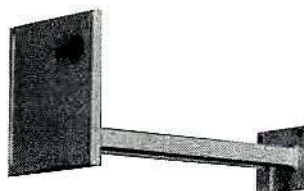
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220MHz lottery

The FCC has conducted its lottery for 220MHz local channels.

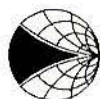
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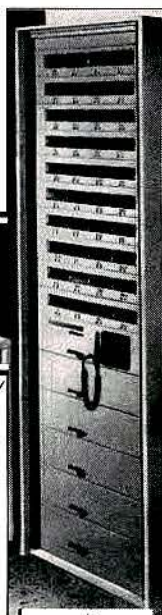
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Readers' choice

Of all the new products and services in the July 1992 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

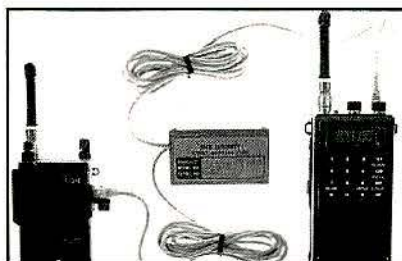
Digital radio changes trunked system



Circle (500) on Fast Fact Card

The Aegis digital radio technology from **Ericsson GE** fits the EDACS trunked system and conventional systems. The system provides voice technology with added security against typical scanners.

Portable repeater interface boasts field programmability



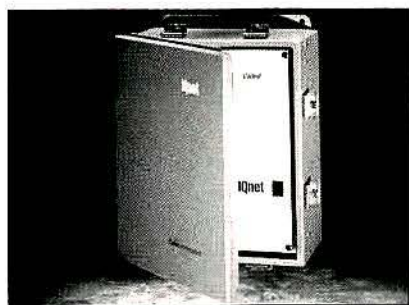
The RPT-1 portable repeater interface converts any ICOM hand-held into a repeater. The **SWS Security** interface features field-programmability, good audio quality and rugged construction.

Circle (501) on Fast Fact Card

SCADA unit boasts 4,800-baud modem

The IQnet high-speed SCADA unit from **Coded Communications** features a built-in 4,800-baud modem and RS-422 interface. The unit's controls can be accessed remotely and adjusted. Other features include high network throughput; modular design; digital and analog monitoring capability; and reliability.

Circle (502) on Fast Fact Card

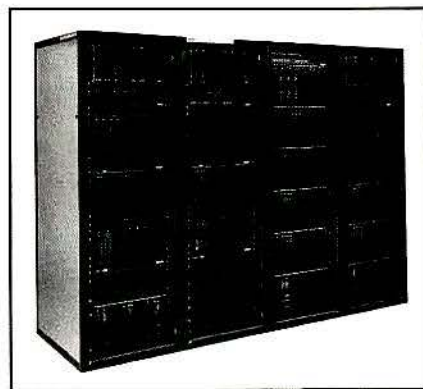


Mobile repeater gains type acceptance

The KG106 mobile repeater from **Kyodo West** meets FCC type acceptance. The unit combines the functions of a mobile and repeater in one unit with full duplex and works in UHF, VHF or crossband applications.

Circle (503) on Fast Fact Card

Redundancy option available for paging terminals



Redundancy from **Glenayre** provides protection against loss of service due to a single component failure without the need to duplicate all of the peripheral cards, such as trunks, voice storage and outputs. It is optionally available for the GL3000L and GL3000XL paging terminals. Components include the CPU, RAM, SIO, switchcard, BMIC card, SCSI host adapter, disk drives, power converters and CPT card.

Circle (300) on Fast Fact Card

Software outlines FCC forms for easy fill-in by computer

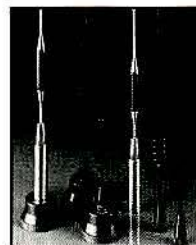
Slattery Software has released five versions of its Quickform software for FCC licensing. The PC-based software is for FCC forms 401, 402, 489, 494 and Schedule B. The software displays a simulated image of the form on the screen for easy fill-in, then prints the form on plain paper using a laser printer. Forms are saved automatically so licensees can retrieve, duplicate, merge, selectively tag and batch print forms.

Circle (301) on Fast Fact Card

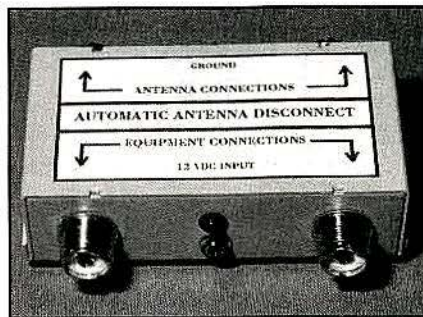
SMR antennas offer unity, 3dBd, 5dBd gain

Mobile antennas designed for trunking radio are available from **Larsen Electronics**. Seven models using the NMO mount offer unity, 3dBd and 5dBd gain. The antennas are for 800MHz or 900MHz applications.

Circle (302) on Fast Fact Card



Automatic-disconnect products protect electronic equipment

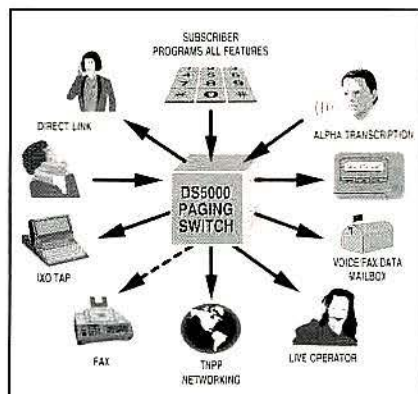


The Automatic Antenna Disconnect unit from **LPS Enterprises** automatically disconnects an antenna when the transmitter or receiver is powered down, either by the operator or as a result of a power failure. The device automatically reconnects the antenna when power is restored. The Automatic Modem Disconnect automatically disconnects and reconnects a computer modem from the telephone line in a similar manner.

Circle (303) on Fast Fact Card

New products

Paging terminal features one universal trunk card



The DS5000 offers fully integrated paging, live telemessaging, alpha transcription, automatic operator assist in non-DTMF areas, voice mail and fax mail. The DS5000 from **Ralco** uses one universal trunk card for voice, data and fax input and output. Features include TNPP, dial-up TNPP and programmable templates for customized services.

Circle (304) on Fast Fact Card

Magnetic mount antenna comes ready to install



The Mini Mag magnetic mount antenna is for conventional and trunked mobile radios in the 800MHz and 900MHz bands. It comes factory tuned and ready to install. The compact antenna from **Motorola** is an alternative to glass-mount antennas and antennas that require mounting holes to be drilled into the vehicle body.

Circle (305) on Fast Fact Card

Triaxial antenna cable suits shielded environments

The nu-Trac antenna cable employs a patented triaxial design to achieve controlled coupling of RF energy between the cable and shielded environments (such as tunnels, subways, ships and buildings) to achieve RF coverage. Frequencies range from less than 100MHz to more than 2GHz. The cable from **Times Microwave Systems** passed the IEEE 383 vertical tray



flame test and is qualified to MIL-C-17G standard. The cable, connectors and accessories are available in 1/2", 3/4" and 1 1/4" sizes.

Circle (306) on Fast Fact Card

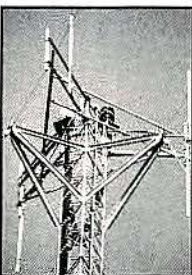
Software plots Alaskan terrain

Digital topography data for Alaska is available from **SoftWright**. The elevation data can be used with the Terrain Analysis Package system for modeling the performance of radio communication systems. The data can be used to generate 3D depictions of the terrain with county boundaries, cities and airport locations.

Circle (307) on Fast Fact Card

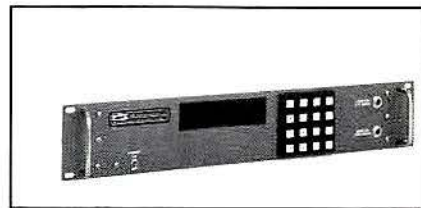
Guyed antenna tower features all-welded solid-leg design

The S-36 guyed tower features a 36-inch face with all welded 20-foot long tower sections and high strength solid round tower legs and bracing. The **Andrew** tower can support a wide array of antenna configurations and is designed in accordance with EIA-222-E specifications. Other features include built-in climbing ladders, built-in cable supports for 12 cables, complete offering of cellular platforms and mounts, and universal bolt on microwave mounts.



Circle (308) on Fast Fact Card

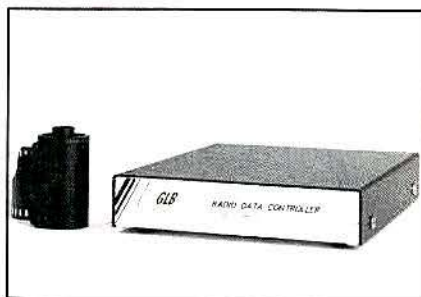
Switch offers 3-way matrix control



The MTX-1616 audio and digital switch matrix provides switching audio and control signals simultaneously in small communications systems. The **JPS Communications** unit has a 3-way matrix control: via PC software, via front panel and via parallel interface. As many as 24 complete matrix set-ups may be programmed and later selected with a single contact closure.

Circle (309) on Fast Fact Card

Radio data controller suits GPS, public safety applications



The radio data controller (RDC) is capable of transmitting data over existing radio at 9,600bps or at 1,200bps on most trunked radios. Data communication takes place in either asynchronous or synchronous mode on either dedicated data or shared voice channels. The unit from **GLB Electronics** is user programmable and supports GPS, public safety, networking and data acquisition applications.

Circle (310) on Fast Fact Card

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Circle (89) on Fast Fact Card

Hand-held unit transmits fax, alphanumeric paging messages

Pagentry is a hand-held fax transmitter and alphanumeric radio page message entry and transmission device. Measuring 3" x 5" x 3/4", the unit is battery-powered and contains an alphanumeric keyboard and LCD. Message text may be entered at any time and later transmitted to radio pagers

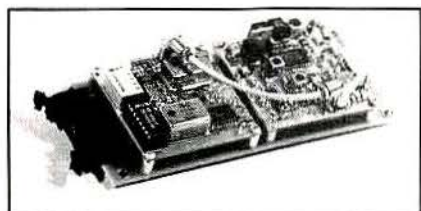
or fax machines. The unit can transmit and receive E-mail, be used as a hand-held data terminal, or be used as a TDD. The **RTS Electronics** unit also provides a name and telephone number directory, a touchtone dialer, alarm and reminder functions, and a calculator.

Circle (311) on Fast Fact Card

RF modules boast range of 850MHz-960MHz

A synthesizer PROM control interface with an optional serial or parallel microprocessor control are in **RF Industries'** RF modules. Features include multiple channels, 12.5kHz or 25kHz channel spacing and a frequency range of 850MHz to 960MHz. The modules measure 2" x 2".

Circle (312) on Fast Fact Card



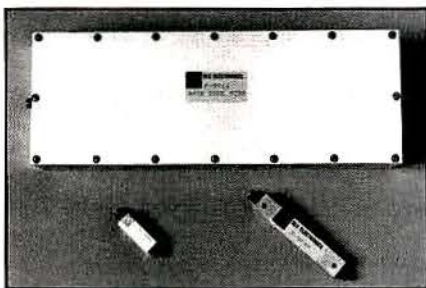
Telemetry unit operates in three modes on wireline or two-way radio

The T2160 offers an economical solution for remote control and monitoring systems. The 6.3" x 3.94" x 1.0" self-contained unit from **Sigtone** has eight digital inputs and outputs and two analog inputs and outputs. The typical application is a master-remote arrangement using two

T2160 units. The units are linked together via wireline or two-way radio. The units can operate in three modes: polled, event triggered and combined polled and event triggered. The system can be implemented on an existing VHF, UHF, 800MHz and 900MHz conventional or trunked system.

Circle (313) on Fast Fact Card

Coaxial cavity filters available in 500MHz-40GHz range

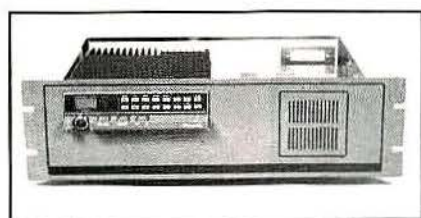


Circle (314) on Fast Fact Card

RLC Electronics offers three cavity filters in the 500MHz-40GHz frequency range. The coaxial cavity filters are for low-loss, narrowband requirements. The interdigital cavity filter is for both narrowband and broadband, low-loss applications, and it provides symmetrical rejection characteristics. The combine cavity filters are used for narrow and moderate bandwidth situations, offering high side-rejection characteristics.

Repeaters offer compact design, continuous duty operation

The continuous-duty Syn-Tech II repeaters and dispatch stations are fully synthesized and programmable for as many as 320 channels in as many as 16 groups. Frequency range for VHF models is 136MHz-160MHz or 150MHz-174MHz; RF output is adjustable from 1W-40W. UHF frequency range is 406MHz-430MHz or 450MHz-470MHz; RF output is 1W to 30W. Configurations can be either desktop cabinet or 19" rack-mount. Rack-mount units are 5.5" high; desktop units are 8" x 21" x 15". All models from **Midland** have



full-duplex capability, programmable CTCSS/DCS with carrier operated relay and programmable dual-priority channel scan.

Circle (315) on Fast Fact Card

Catalog features quartz crystals, includes technical information

A 70-page catalog contains sections on quartz crystals, oscillators, filters and build-to-print modules for the military and commercial markets. The catalog from **EG&G Frequency Products** includes engineering and technical information, as well as schematic drawings and charts for both standard and custom applications. Included are photos, specifications and ordering information.

Circle (316) on Fast Fact Card

Handbook serves as paging reference

The Paging Technology Handbook by Neil J. Boucher gives an in-depth view of the paging industry—the technology, opportunities, limitations and pitfalls. Chapters include Basic Radio; Units and Concepts of Field Strength; Site Selection; Antennas; Multiple Transmitter Operation; Switching; Code Format and Error Correction; and Noise and Noise Performance. The handbook from **Quantum Publishing** includes a glossary for easy reference.

Circle (317) on Fast Fact Card

Catalog details cable assemblies

A 24-page catalog from **JB Communications of Watseka** describes high-performance cellular, land mobile and CB cable assemblies, antennas, mounts, connectors and accessories. All products feature a lifetime guarantee.

Circle number (318) on Fast Fact Card

Application note covers measurement accuracy

A 16-page application note shows how to improve measurement accuracy without the need for new test equipment. The application note from **Wiltron** describes how to use precision components with its 5400A scalar measurement system. All the techniques can be used with existing scalar systems.

Circle (319) on Fast Fact Card

Book discusses basic electronics for non-technical readers

Understanding Basic Electronics is written in a style that non-technical readers can read. The chapters form four units: Some Needed Math Skills; Elementary Dc Electronics; Elementary Ac Electronics; and A Few More Building Blocks. Included in the **American Radio Relay League** book are drawings, cartoons and other illustrations that demonstrate the concepts.

Circle (320) on Fast Fact Card

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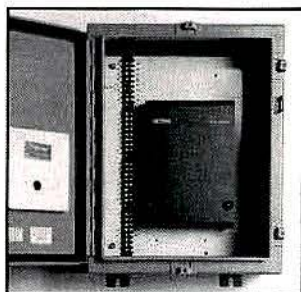
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Circle (90) on Fast Fact Card

Feedback

'Business growing moderately even in economic hard times'

The state of the industry is good according to 32.6% of the respondents to the July 1992 "What Do You Think?" questionnaire. Other responses were:

Excellent	11.6%
Average	18.6%
Fair	14.0%
Poor	11.6%
Needs improvement	18.6%
No answer	2.3%

Readers believe that the following factors contribute to the industry's current status (multiple responses add up to more than 100%).

Economy	55.8%
Cost of doing business	39.5%
Market demand/competition	37.2%
Pricing	27.9%
Other	18.6%

- "Two-way is doing well and experiencing growth even in economic hard times."
- "As far as new work goes, things are improving; as far as repair work, things are dwindling."
- "Cellular phones are taking over traditional users. So few are coming into the marketplace of regular two-way users."
- "Not many new systems being added because of the economy."
- "Plenty of opportunity in the applications of new technologies, expanding markets."
- "Prospects for service and sales are improving after companies have regrouped and economy looks brighter."
- "The new radios are great, but too many unlicensed operators."

Products readers consider to be the fastest growing in the land mobile industry are: (multiple responses add up to more 100%)

Cellular equipment	53.5%
Mobile data terminals	37.2%
Computer products	27.9%
Portables	27.9%
Trunking products	25.6%
Paging equipment	20.9%
Mobiles	16.3%
Satellite equipment	14.0%
AVL equipment	9.3%
Antennas	7.0%
Test equipment	7.0%
Ancillary equipment	4.7%
Combiners, duplexers and multicouplers	2.3%
Other	11.6%

Readers believe the following technological advances will translate into future industry growth:

- "Advanced digital communications."
- "Digital narrowband technology or spread spectrum technology that will use spectrum more efficiently."
- "Multiband mobiles, multiband trunking, SMR and cellular system combinations."
- "Smaller size integration of personal computers, radios and mobile data terminals into networking designed to specific applications."
- "Personal communications networks."



P eople

Andrew McLorinan, regional business manager within the Ericsson Business Communications AB office in Stockholm, Sweden, joins Ericsson GE in Lynchburg, VA, as manager of sales and commercial operations in the Far East, Pacific, Latin America and Middle East region.

Promotions at E. F. Johnson, Minneapolis:

Frederick G. Hamer, vice president of sales and distribution, advances to vice president of international sales.

Jeffery L. Fuller, vice president and general manager of systems products, moves up to vice president of North American sales.

Changes at Broadcast Communications (BC), New Glarus, WI:

George Brewe leaves AT&T, Chicago, as a communications technician, to join BC's telephony industry systems integration staff.

Robert Leacock departs L&R Communications, Sacramento, CA, as operations manager to become senior operations manager with BC.

Merlin Anderson exits Motorola, Schaumburg, IL, as a sales engineer, to become BC's senior electrical engineer.

Joel E. Claybrook leaves DMDA, Dallas, as senior vice president, to become vice president and chief financial officer at Pinpoint Communications, Dallas.

Jack W. Blumenstein, president of ARDIS, Lincolnshire, IL, a joint venture between Motorola, Schaumburg, IL, and IBM, Tulsa, OK, advances to chairman. He succeeds **Mort Topfer**, who continues as president and general manager of Motorola's Land Mobile Products Sector. **Frank T. Wapole**, vice president and general manager of Worldwide Business Development for Motorola's Land Mobile Products sector, advances to president of ARDIS.

Changes at Bendix/King, Lawrence, KS:

Ron Aul moves from the company's General Aviation Avionics Division in Olathe, KS, as senior contract administrator to join the Lawrence division as assistant credit manager.

George Emro, design engineer, advances to technical services manager.

John E. Welsh III and **Haley Barbour** are newly elected members of the Mobile Telecommunications Technologies (MTL) board of directors. Welsh is managing director of Seaport Capital, New York. Barbour is a partner in the law firm of Barbour & Rogers, Washington, DC.

Patrick H. O'Rourke departs Selectone, Hayward, CA, as director of sales and marketing to join PanaVise Products, Sparks, NV, as director of sales and marketing.

Bill Minear leaves Dynatech Tactical Communications, Hudson, NH, as national sales manager for RF products to become national sales manager at Sonic Communications, New Ipswich, NH.

Maurice Nieman exits Pactel Teletrac, Los Angeles, as vice president and general manager to join Coded Communications, Carlsbad, CA, as vice president of group operations to head all North American operations.



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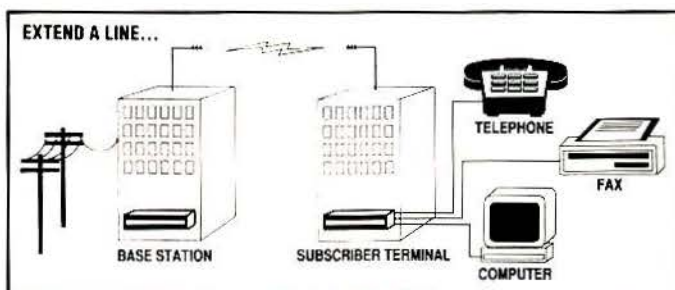


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L etters to the editor

Combining antennas:

The following is Brian Henderson's reply to John Smith's letter, which appeared in January's column:

I agree with your comments about phased antennas being mounted in exactly the same configuration. I under-emphasized the point in my article.

The article's "item 2" points out that "Antennas must be fed in phase so the individual antenna patterns add together for maximum transmitted and/or received signal." No matter what commercial or handcrafted phasing harness type is used, antennas must be mounted and fed identically.

When gamma-fed antennas are stacked, the gamma rods must point in the same direction. When dipole antennas are combined, all driven sides of each dipole element must face the same direction, up or down.

Failure to follow this rule results in signal cancellation and poor radio coverage due to the 180° phase shift. Note that several antenna manufacturers apply white or red tape on one side of the feedpoint to indicate the antenna's polarity. These indications can be used as an aid when stacking and phasing antennas.

If it is physically impossible to mount antennas in the same configuration, add 0.5-wavelength of coax (as Mr. Smith advises) between one antenna and the phasing harness to ensure the antenna patterns are in phase. This length of coax connects between the antenna feedpoint cable and the phasing harness. Use conventional 50Ω cable calculated to be 0.5-wavelength long according to the correct velocity factor.

Mr. Smith's second point about stacking antennas in the same plane is correct, too. This advice applies when stacking any antennas to fill in an area with poor coverage.

The only way to achieve the theoretical 3dB gain is to stack antennas in the same direction.

For example, if two yagis are installed back to back to cover opposite directions along a highway, each antenna will work independently in each direction. Half the transmitter power goes to each yagi.

Antenna patterns always add together when antennas are phased properly. The combination's pattern can be predicted by computer analysis, as Mr. Smith's letter reads.

Mr. Smith points out a variation of the phasing harness using quarter-wavelength sections of 62.5Ω coaxial cable to feed 75Ω hardline.

The mathematics support the idea, and practical implementations work well. I

have made such a 62.5Ω coaxial line out of copper pipe for one project. Unfortunately, I have yet to find a commercial source for 62.5Ω coaxial cable with a quality high enough for a communication system. Most commercial cables I have examined are either 50Ω, 75Ω, 93Ω or 135Ω impedance. If there is a commercial source for 62.5Ω cable, I would like to examine the product.

The loss of 75Ω CATV coaxial cable is similar to the loss of air dielectric cable made by Andrew, and it often is available in 100-foot to 200-foot lengths just for the asking.

Brian J. Henderson, P.Eng.
Senior Engineer
Canadian Western Natural Gas
Calgary, Alberta

The two toughest problems facing me on the job are:

- convincing customers to buy good-quality radios instead of cheap ones that do not hold up to everyday use.
- radio sales by discount stores and auto parts outlets.

Dale Hughes
Owner
Hughes Electric
Ketchikan, AK

The two toughest problems facing me on the job are:

- keeping our repeaters on line and on the air.
- getting the repairs to turn around fast enough.

Genie Feminella
Secretary
Teva Communications
New York

The two toughest problems facing me on the job are:

- paging transmitters that refuse to use bandpass cavities.
- unmanaged radio sites.

Dan Renfro
Chief Engineer
North Carolina
Emergency Patrol
Hickory, NC



1993 Buyers' Guide Correction

Please turn to page 54 of the December 1992 issue and correct the toll-free number for CPI Communications as follows:

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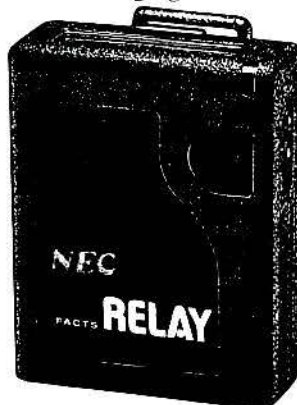
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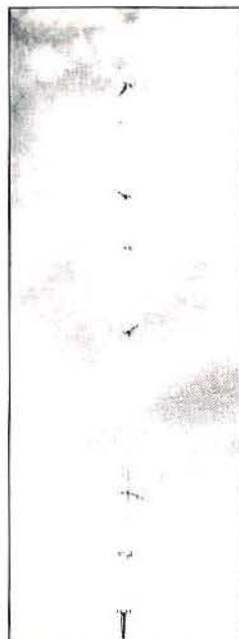
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C7019 HDOSET adapter	U	\$40
Model H10-30, 2-Muff HDOSET, w/phono plug	N/U	\$75/50
P/N 18253G06, Jack 5830/Jack 88	N	\$10
P/N 40082G01, Windscreen mic, M-4	N	\$1
P/N 10117G11, HDOSET spring assembly	N	\$3

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(Mot Model BDN6486), 2-Muff HDOSET/HT600 series	N	\$175
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P/N NMN6065	1-N/2-U	\$60
HT220 Univ. Surveillance assembly sim. to ZMN6014	N	\$10
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HT220 HDOSET adapter cable, Univ. model (NKN6189)	N	\$10
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
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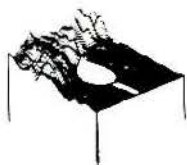
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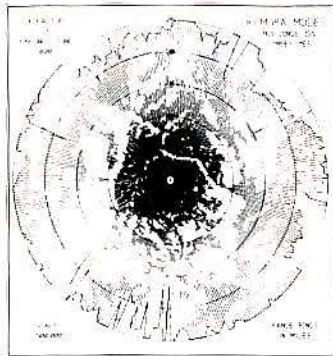
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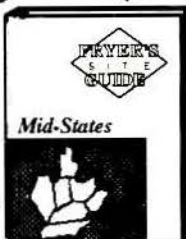
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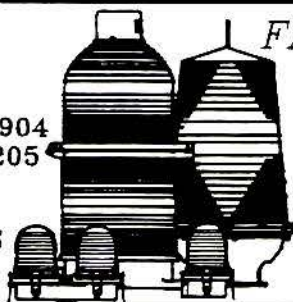
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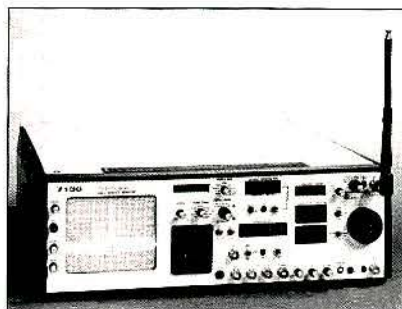
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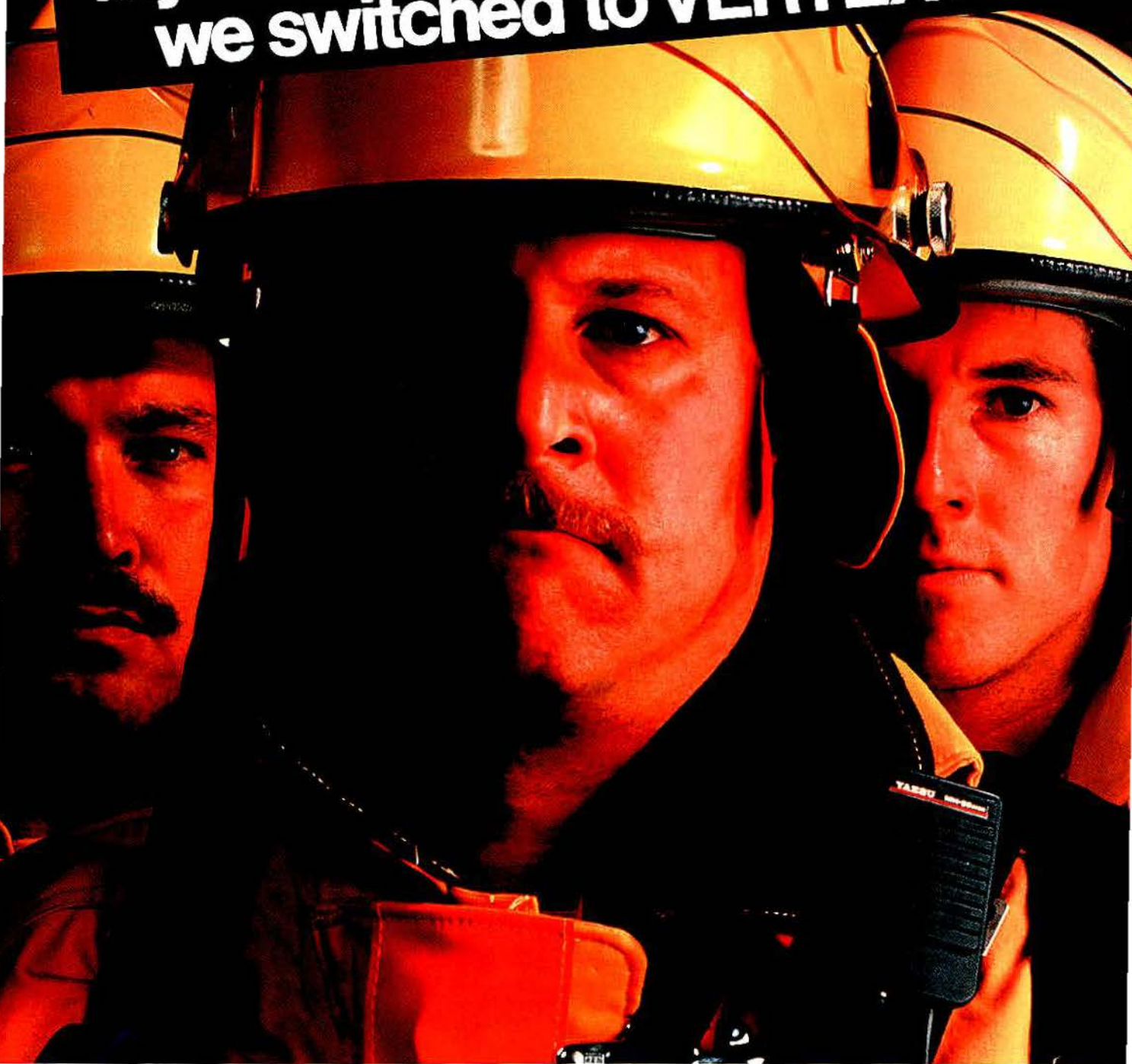
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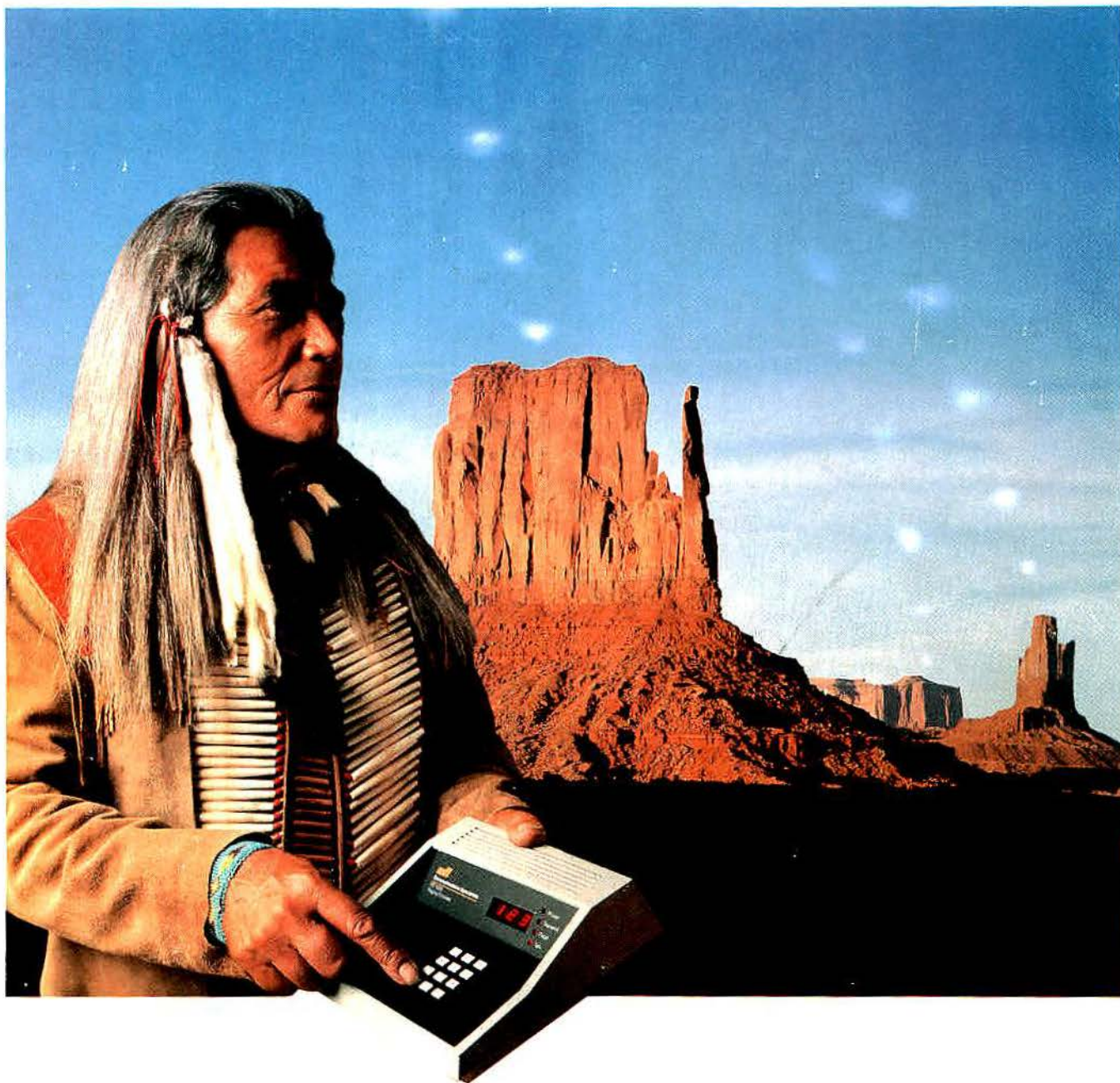


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